Prepared For:
USAID-SARI/Energy Program
www.sari-energy.org

Subsidies and Financial Mechanisms for Rural Energy Services

Nexant

November 2003

Subsidies and Financial Mechanisms for Rural Energy Services

for

United States Agency for International Development

Under

South Asia Regional Initiative for Energy

Prepared by

Nexant SARI/Energy

Acknowledgements

The development of this report was made possible by funding from the United States Agency for International Development (USAID) and through the collaborative efforts of Nexant, Inc and its local consultants. In addition, Nexant SARI/Energy wishes to acknowledge the following organizations and people who provided inputs in terms of discussions and providing information for the study.

Bangladesh

- Md. Khalilur Rahman, Rural Electrification Board
- Mr Dipal Barua, Grameen Shakti
- Ms Asma Haque and Hasna J Khan, Prokaushali Sangsad Ltd
- Md. Iqbal, World Bank Office, Dhaka
- Mr Fouzul Kabir Khan, Infrastructure Development Company Ltd (IDCOL)
- Md. Tarik-ul-Islam, UNDP Bangladesh

India

- Mr RK Chakraborty and Mr S Ghosh Dastidar, Rural Electrification Corporation Ltd
- Dr Bhaskar Natarajan, India Canada Environment Facility
- Ms Gayathri Ramachandran, Environment Protection Training and Research Institute
- Mr Ibrahim H. Rehman and Mr Sameer Maithel, TERI
- Mr Thomas J. Pullenkav, General Manager Projects, SELCO
- Mr Subir Nathak, Market Dynamics Ltd
- Mr Pavankumar Siddhi, Sungrace Energy Solutions Ltd
- Rural Electric Cooperative, Singur Haripal
- Rural Electrification Corporation Ltd, Hyderabad

Nepal

- Dr Bikash Pandey, REPSO Nepal, Winrock International
- Mr Madan B Basnyat, Alternative Energy Promotion Center
- Mr Kiran Man Singh, Rural Energy Development Programme (UNDP)
- Mr Devendra Prasad Adhikari, Micro Hydro Component Coordinator, ESAP, DANIDA
- Mr Sridhar Devkota, Small Hydropower Promotion Project, GTZ
- Dr Santosh Nand Mishra, Rural Electrification and Small Hydro Department
- Mr KB Rokaya, ITDG South Asia
- Ms Sapna Shakya, Himalayan Light Foundation

Sri Lanka

- Mr Jayantha Nagendran, DFCC Bank
- Mr Susanto Pinto, SELCO Solar Lanka Ltd
- Mr Priyantha Wijesooriya, Consultant
- Mr Lalith Gunaratne, Consultant
- Dr Tilak Siyambalapitiya, Resource management Associates Ltd
- Mr S.M.G. Samarakoon, Consultancy and Professional Services Ltd
- Mr Sanath Weerakkody, Solar Industries Association
- Mr Asoka N Abeygunawardana, Energy Forum

- Mr Romesh Das Bandaranaike, Eco Power Ltd
- Ms Indrani Hettiarachchy, SEEDS
- Mr Lakshman Jayasuriya, Alpha Thermal Systems Ltd
- Dr Susil Liyanarachchi, ITDG South Asia

List of Acronyms

ACRE	Area Coverage Rural Electrification
ADB/N	Agricultural Development Bank, Nepal
AEPC	Alternate Energy Promotion Center, Nepal
BPDB	Bangladesh Power Development Board
CEB	Ceylon Electric Board
DANIDA	Danish International Development Agency
DESA	Dhaka Electricity Supply Authority
DFCC	Development Finance Corporation of Ceylon
DPR	Detailed Project Report
ECS	Electricity Consumer Society
ESAP	Energy Sector Assistance Program, Nepal
ESD	Energy Services Delivery project, Sri Lanka
ESMAP	Energy Sector Management Program
FAO	Food and Agricultural Organization
GEF	Global Environment Facility
hp	Horsepower
HT	High Tension
IDA	International Development Agency
IDCOL	Infrastructure Development Company Ltd
IREDA	Indian Renewable Energy Development Agency, India
IREF	Interim Rural Energy Fund, Nepal
ITDG	Intermediate Technology Development Group
km	Kilometers
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt Hour
LPG	Liquid Propane Gas
LRMC	Long-run Marginal Cost
LT	Low Tension
MFI	Micro-financial Institution
MGSP	Mini-grid Support Program, Nepal
MHP	Micro-hydro project
MIS	Management Information System
MNES	Ministry of Non-conventional Energy Sources, India
MST	Ministry of Science and Technology, Nepal
MW	Megawatt
NEA	National Electricity Authority, Philippines
NGO	Non-governmental organization
NRECA	National Rural Electric Cooperative Association
NRS	Nepalee Rupee
O&M	Operations and Maintenance
PBS	Palli Bidyut Samities
PCI	Participating Credit Institution
PEA	Provincial Electric Company, Thailand
PTA	Performance Target Agreement
PV	Photovoltaic

REB	Rural Electric Board
REC	Rural Electrification Corporation, India
REC	Rural Electric Cooperative
RECS	Rural Electric Cooperative Societies
RERED	Renewable Energy for Rural Economic Development
RESCO	Rural Energy Service Company
RRD	Renewable Resources Development project, India
RET	Renewable Energy Technology
Rs	Indian Rupee
SARI	South Asia Regional Initiative
SARI/Energy	South Asia Regional Initiative for Energy
SEB	State Electricity Board
SEEDS	Sarvodaya Economic Enterprises Development Society
SELCO	Solar Electric Light Company
SERC	State Electricity Regulatory Commission
SHS	Solar Home System
SIA	Solar Industries Association, Sri Lanka
SLR	Sri Lankan Rupee
SPV	Stand-alone Photovoltaic
SRF	Special Reserve Fund, India
T&D	Transmission and Distribution
TFC	The Finance Company
Tk	Bangladeshi Taka
UNDP	United Nations Development Program
USAID	United States Agency for International Development
US$	United States Dollar
W	Watt
WBERC	West Bengal Electricity Regulatory Commission, India
WBSEB	West Bengal State Electricity Board, India
Wp	Watt power

Contents

Executive Summary

Background

In spite of large-scale expansions in energy service provision, more than two billion people across the world lack access to modern energy services, with some of the lowest energy consumption levels in the world found in South Asia. Governments have made considerable efforts to increase energy services for people in rural areas of developing countries, and subsidies and other financial mechanisms have been a key element in all these initiatives. While the access of the poor to energy services has improved over the years, the direct impact of financial mechanisms and subsidies has not been entirely satisfactory.

This guide reviews the existing subsidies and financial mechanisms aimed at expanding the access of rural households to energy services in the South Asia Regional Initiative in Energy (SARI/E) countries (India, Nepal, Bangladesh, and Sri Lanka) and proposes design principles and guidelines for enhancing their effectiveness and impact, specifically for three categories of rural energy service provision:

1. Grid-connected rural energy service delivery
2. Off-grid centralized rural energy services
3. Off-grid decentralized rural energy services

The findings of the study are based on a literature review and interaction with key stakeholders in the study countries.

Design Principles for Rural Energy Subsidies

To be cost-effective, efficient, and useful for rural and poor people, energy subsidies should have two main goals: (1) to assist the poor in gaining access to higher quality energy services and (2) to provide business incentives to serve rural and poor consumers. The following principles are suggested as necessary for the pursuit of these goals:

- **Who to Subsidize:** Subsidies for rural energy should focus on two categories: (1) households for whom modern energy is a high priority and (2) the poorest existing customers, whose consumption is very small because of high prices and lower incomes
- **What to Subsidize:** In general, subsidies should be applied to access or connection costs, not to operating costs or on-going consumption
- **How to Subsidize:** Demand-side subsidies, involving partial funding of connections or partial payment of regular energy bills, work better than fuel or supply-side subsidies because they have better targeting properties and provide stronger incentives for expanding coverage and sustaining services. They also, however, have higher administrative demands. In terms of producer subsidies, supply-side grants per systems sold are beneficial to the development of market infrastructure, attracting new players and allowing participating companies to expand. Moreover, when there is competition, there is a pressure to pass on the grant to the consumer
- **Tariff Policy:** The tariff structure should be based on sound commercial principles and take into account a commercially based allocation of costs among consumers according to the burdens imposed on the system. It should ensure a minimum level of service and a

reasonable degree of price stability to the consumers and be simple enough to facilitate metering and billing

Recommendations for Subsidies and Financial Mechanisms

Subsidies and Financial Mechanisms for Grid-connected Rural Electricity Supply

General Principles

- To provide capital grants during start-up
- To provide concessional interest rates and longer (non-commercial) grace periods
- To phase out subsidies for mature rural electric cooperatives

Subsidy Delivery Mechanisms

- **Variable Level of Financing:** The nature and extent of financial support need not be uniform across rural electric cooperatives. The level and duration of support should be linked directly to the degree of difficulty that the cooperative is likely to face in attaining financial sustainability
- **Cross-subsidization:** There should not be any subsidization across rural electric cooperatives: each should operate as an independent utility, ensuring its own sustainability by managing its own costs and realizing adequate revenues
- **Support from the State Utility:** The rural electric cooperatives should be viewed as an integral part of the state electricity board, while maintaining functional autonomy

Subsidy Mechanisms for Rural Electric Cooperatives

- **Financial Support:** During start-up, in the form of constructed and handed-over line assets that meet connection criteria
- **Stability in Power Purchase Rates:** The state utility must ensure a reasonable degree of stability in power purchase rates
- **Support for Efficiency Enhancement Measures:** Such as technical assistance in developing projects, feasibility studies, energy demand forecasting, developing sound operating systems and management practices, and training local staff

Subsidy Mechanisms for Final Consumers of Electricity

- **Financing Access Costs:** The costs of residential connection may present a substantial barrier for those living at a near-subsistence level. Some options that can be explored to reduce the burden of access costs include
  - Offering micro-credit for financing the cost of connections
  - Reducing these charges, or spreading them over a several years, even if it means charging more per unit of electricity
  - Treating part of the internal wiring costs as part of the connection investment and adding it to the monthly extra charge during the payment period
- **Lifeline Tariffs for Poor Consumers:** In areas where the income levels are very low, it may be necessary to subsidize consumption as well. A monthly lifeline rate of 25 kWh or less would encourage poor households to adopt electricity

Exit Strategy

- Clear, time-bound financial goals for financial support should be pre-announced. In general, the rural electric cooperatives should at least cover operating and management costs in the first three to four years, cover operating and management costs and debt servicing until year 10, and thereafter generate surpluses

Subsidies and Financial Mechanisms for Off-grid Decentralized Energy Systems

General Principles

- To pre-announce that subsidies will be given only for a pre-defined period
- To pre-announce declining subsidy rates during the period
- To promote maximum number of different system sizes on the market

Subsidy Delivery Mechanisms

- **Use Multiple Credit Channels:** Involving NGOs in mediating commercial bank credits and assisting in functions like identification of beneficiaries, conducting credit checks, mediating for loans, and promoting alternative financing mechanisms, such as credit lines, loan guarantees, and hire-purchase and leasing schemes, using group loans/group guarantee schemes to reduce the costs of transactions

Subsidies and Financial Mechanisms for Service Providers/Manufacturers

- **Provide Start-up and Working Capital Loans:** In the initial stages of market development, providing financial support to producers to develop the market and for working capital is a useful strategy
- **Co-finance Market Development and Promotion Costs:** Subsidizing initial trail-blazing costs helps to ensure that the business returns are proportional to the investments made by the market pioneers. Co-financing should be provided for specific promotional campaigns targeted either geographically or at specific stakeholder groups, such as banks
- **Declining Subsidies over a Pre-defined Time Horizon:** It is important to (1) pre-announce that subsidies will be given only for a fixed period and (2) have pre-announced declining subsidy rates during the period

Subsidies and Financial Mechanisms for Local Institutions

- **Facilitate Involvement of Local Micro-finance Institutions (MFIs):** By providing refinancing facilities to enable them to provide medium-term loans and providing them with capacity-building support for better credit management and other technical expertise

Subsidies and Financial Mechanisms for Final Purchases

- **Provide Flat Product Subsidies:** On a declining basis, and linked to product size, where smaller systems get slightly higher subsidies per Wp.
- **Offering Consumer Choice:** Offer choice to consumers by making subsidies available for a range of system sizes and configurations
- **Offer Financing Options:** For meeting first costs

Subsidies and Financial Mechanisms for Centralized Off-grid Energy Systems

General Principles

- **Target Support:** To regions that are most likely to benefit from electricity
- **Focus on Reducing the Cost of the Initial Investment:** Increasing the numbers of people who have access to electricity
- **Avoid Applying Un-ending Subsidies to Operating Costs:** Or more specifically do not directly subsidize the price charged to the energy end user

Subsidy Delivery Mechanisms

- **Categorization of Projects for Financial Support:** It is useful to distinguish community-based energy projects into three categories, based on economic characteristics of the target market and expected level of financial sustainability:
    - Projects that are intended to make a profit. Any entrepreneur who identifies a profitable energy project is given the opportunity and the necessary guarantees to implement it (micro-hydro projects based on productive end uses would fall in this category)
    - Projects that are non-profitable but, if managed well, are capable of covering their operating and maintenance costs. Such projects may be given partial financial support, and the communities can be expected to generate the balance from other sources, including their own resources. This category will include projects directed for lighting application and promoting end-uses around it
    - Projects that are in extremely remote and economically underdeveloped areas that cannot even be expected to generate enough resources to meet operational expenses
- **Realistic Assessment of Comparative Costs:** It is essential to carry out realistic economic and technical evaluations and to compare costs of proposed projects with conventional alternatives. Comparative costing must be made mandatory in detailed project report (DPR) preparation
- **Financial Support for Discrete Components:** It is a useful strategy to break the project cycle into discrete activities, such as (1) pre-installation work (pre-feasibility, community organization), (2) manufacturing (supply of turbines), and (3) installation work, and to institute separate financing mechanisms for each of these. This is a good mechanism for risk minimization as the appropriateness of the design can be verified by independent experts who have not been involved in the project feasibility work
- **Role of Village Community:** There should be a specific role for village-level community institutions, which should be made financially accountable by routing a part of the subsidy through it

Subsidy Mechanisms for Off-grid Projects

- **Output-linked Subsidies:** It is recommended that a flat rate linked to output per kW be applied for micro-hydro systems as it provides a stronger incentive for low-cost projects than a percentage rate. The advantages are that it is easier to administer and it eliminates incentives for artificially inflating the cost of investment and encourages searching for cost reducing options

- **Ceiling on Financial Support:** There should be a ceiling on the subsidy amount that is provided, either in the form of maximum amount per installed kW capacity or as a maximum per household that will be connected. The latter option is most appropriate, and can be fixed on the basis of an analysis of the cost structures of recently implemented projects
- **Building Support Services:** In addition to direct subsidies for investments and feasibility studies, indirect subsidies are also required to meet some of the costs of intermediation discussed earlier. These include subsidies for supporting the build-up of professional advisory and training services
- **Minimum Level of Self-finance:** Subsidy support programs should insist on minimum levels of self-finance (including non-subsidized loan finance) of at least **50%**

Tariff Policy

- **Variable:** The tariffs in isolated grids should be allowed to vary.
- **Sufficient for Operating Costs:** The revenue from the tariffs must be sufficient to cover the costs of operation, including the accumulation of reserve funds for major replacement or rehabilitation expenditure. If the population is unwilling to pay for such tariffs, the project should not be implemented. Guidelines should be provided, however, for tariff setting for two reasons: to ensure the financial viability of community-owned projects (adequate allocations for major repairs and for loan repayments) and to reduce tensions in tariff negotiations between entrepreneur-owners and the customers.

South Asia has among the lowest energy consumption levels in the world. The access to energy is particularly poor in rural areas, which are characterized by an overwhelming dependence on biomass fuels, limited penetration of commercial fuels, slow transition from traditional to modern fuels, poor grid expansion due to financial constraints, and rural-urban disparities in energy consumption patterns.

Governments have made considerable efforts to increase the provision of energy services to people in rural areas of developing countries, including expansion of the electricity grid, improvement in the availability of liquid fuels, and promotion of renewable energy technologies. The provision of subsidies and other financial mechanisms has been a key element in all these initiatives. Although access of the poor to energy services has improved over the years, the direct impact of financial mechanisms and subsidies has not been entirely satisfactory.

The South Asia Regional Initiative in Energy (SARI/E), which has been playing a catalytic role in regional energy cooperation, has been involved in developing policies aimed at enhancing the availability of energy to meet regional development needs.

1.1 What is the Purpose of this Guide?

This guide reviews the existing subsidies and financial mechanisms aimed at expanding the access of rural households to energy services in the SARI/E countries (India, Nepal, Bangladesh, and Sri Lanka) and proposes design principles and guidelines for enhancing their effectiveness and impact. This guide is based on a literature review and interaction with key stakeholders in rural energy provision in the SARI/E countries, and it is bolstered by a review of international experiences with subsidies and financing mechanisms from outside the region. This guide focuses on rural electrification[1] and features case studies of subsidies and financial mechanisms in three categories of service provision:

1. **Grid-connected Rural Energy Service Delivery:** The rural electric boards (REBs) of Bangladesh and rural electric cooperatives (RECs) of India
2. **Off-grid Centralized Rural Energy Services:** Village hydro systems in Nepal and Sri Lanka
3. **Off-grid Decentralized Rural Energy Services:** Stand-alone photovoltaic (SPV) systems in the four countries

The guide is intended to provide an understanding of the principles underlying subsidies and financial mechanisms for rural energy services. It has been designed for policy makers and practitioners in the rural energy sectors in the region. The application of these guidelines is intended to facilitate the process of establishing the overall framework and identifying principal elements necessary to subsidize rural energy service delivery in the region.

[1] It is evident that rural energy is more than electricity. Especially in the study region, wood and other biomass fuels are of paramount importance. But electricity is the most capital intensive and institutionally most complicated aspect of rural energy.

1.2 What is in this Guide?

The guide is divided into nine sections. Although there is a progression in terms of ideas and logic from sections 2 to 8, it is possible to abstract and use each of the individual sections independently.

Section 2 sets the overall context of rural energy use trends and issues. It presents a brief outline of traditional subsidies employed for the energy sector, including the theoretical bases. Finally, it reviews the existing subsidy regimes in terms of their overall effectiveness in improving access to rural energy as well as constraints and lacunae.

Section 3 discusses the design principles for rural energy subsidies in the context of the energy needs and affordability of the rural customer. It identifies the elements of rural energy subsidies in terms of who to subsidize, what to subsidize, and how to subsidize, as well as principles for deciding on a tariff policy for final customers.

Section 4 documents projects and programs where subsidies and financial mechanisms have been used effectively to improve rural energy access. These include the REB model of Bangladesh; the RECs of India; the World Bank-supported Energy Services Delivery project (ESD) and Renewable Energy for Rural Economic Development (RERED) projects of Sri Lanka; the Renewable Resources Development project (RRD) of India; and the Nepalese micro-hydro program. In addition to case studies from the region, brief examples of experience throughout the world are also presented.

Sections 5 through 7 provide recommendations for subsidy principles to be followed. Section 5 covers rural electric cooperatives, Section 6 off-grid decentralized options, and Section 7 off-grid centralized systems like village-level micro-hydro. While the recommendations are based largely on the experiences of the four SARI/E countries, lessons have also been drawn from other applicable international experiences.

Section 8, the conclusion, presents a brief summary of the guidelines, abstracted from the specific recommendations for the three categories presented sections 5 through 7.

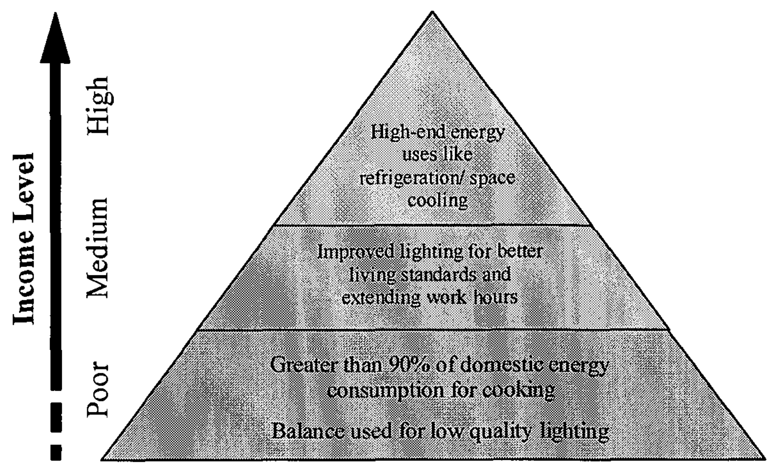
Section 9 is a list of the references consulted in the writing of this guide.

Section 2 Background: Improving Access to Energy Services in Rural Areas

2.1 Dimensions of the Rural Energy Problem

There is an unmistakable relationship between energy and sustainable development. Although energy is not an end in itself, it is an essential tool to facilitate social and economic activity. Thus, the lack of available energy services correlates closely with key aspects of sustainable development, such as the alleviation of poverty, advancement of women, and protection of the environment. Emphasis on energy services is particularly important in developing countries, where the current levels of energy services are low.

Thus far, many efforts have been undertaken to increase provision of energy services for people in rural areas of developing countries. According to a World Bank report, grid-based rural electrification programs have benefited about 800 million people over the past decades (UNDP 2003). In spite of these efforts, however, approximately two billion people still do not have access to modern forms of energy[2], such as electricity and liquid fuels.



Source: Adapted from FAO 1999

Figure 2-1 Income Levels and Energy Uses

These are some of the key features of rural energy consumption in developing countries:

- Households are the major consumers of energy: their share of gross rural energy consumption averages more than **85%** (FAO 1999).
- Cooking and water heating, which are the primary household thermal loads, generally use traditional fuels. Around a third of all energy consumption in developing countries comes from traditional fuels, such as wood, dung, and crop residue (Cecelski 2000). Gathering fuels for cooking is a time-consuming and cumbersome process for rural households and can comprise many hours of daily drudgery, particularly for women.

---

[2] "Modern" energy is used here to differentiate it from the use of biomass fuels in traditional stoves. Thus, for cooking modern fuels would include LPG, kerosene, and the use of biomass in improved stoves. For lighting, the connotation of modern energy refers to the use of electricity because of the significant differences in efficiency when electricity is compared to the direct burning of kerosene or other petroleum products.

- International experience suggests that **15%** of total household expenditure is spent on energy. For household lighting, families that use electricity have lower lighting expenditures while receiving six times more light than households using kerosene (Barnes and Halpern 2000). Respondents to a 1998 survey conducted in Bangladesh reported monthly spending on lighting and battery charging as follows: **39.34%** were spending more than Tk 125, **18.67%** were spending more than Tk 160, and **4.17%** of the were spending more than Tk 300 (Prokaushali Sangsad Ltd 1998).
- Income patterns have a direct bearing on the appliance mix and energy use pattern in rural areas (see Figure 2-1). Wealthier households spend a larger cash amount than do poorer households on energy, but this amount represents a smaller percentage of their income. Conversely, the cash amount poor households spend on energy represents a significant percentage of their income.
- Rural electrification programs have typically involved connecting rural villages and remote areas to a national grid. The tendency is to extend the grid incrementally, moving from large demand centers to smaller ones, reaching towns and settlements in order of increasing capital costs. Supply networks are extended first to large urban areas, then to the peri-urban areas, and finally the rural areas. Where the grid is extended in rural areas, it is characterized by poor reliability, high line losses, and high costs.
- Initial demand for electricity by low-income households tends to be small. This has the unfortunate effect of making the average cost per unit consumed high, as the fixed costs are divided among fewer units (Figure 2-2). As the fixed costs of transmission and distribution depend in part on peak demand (which is concentrated in early mornings and evenings), this demand pattern results in still higher costs for poor rural populations. As demand for electricity increases, the fixed costs can be spread. In developing countries, however, it can take time for demand to grow once access has been provided: People have to wire their houses and buy electrical appliances before they start to buy electricity. Over time, as incomes rise, loads are likely to increase.
- The energy consumption of rural industries amounts to less than **10%** of the rural aggregate in most countries.

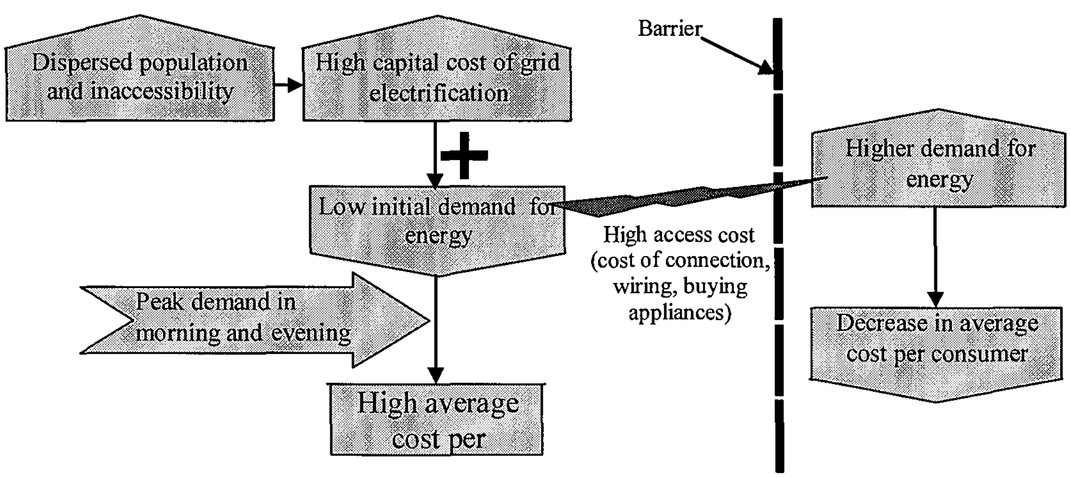


Figure 2-2 Barriers to Accessing Rural Energy Services

Key features of the rural energy scenario in the three study countries are summarized in Table 2-1.

2.2 Energy Subsidies and the Justification for Subsidizing Rural Energy

Energy subsidies have been defined in many ways. One of the most common defines an energy subsidy as "any measure that keeps prices for consumers below market levels, or for producers above market levels or that reduces costs for consumers and producers" (UNEP 2002). Some of the commonly used theoretical bases for subsidies are as follows:

- **Cash Break-even:** This approach for quantifying subsidies is based on financial analysis and involves comparing actual to cash break-even revenues, based on tariffs that would be necessary to meet cash operating expenses, current debt liabilities, and part of investment needs, accepting existing levels of operational efficiency. This is a conservative objective, and does not provide for a return on investment.
- **Long-run Marginal Cost (LRMC):** LRMC is the future cost of power, which takes account of additional investments, consequent capacities, and projected variable costs. From a theoretical perspective, marginal cost pricing methods provide the most appropriate signals for the pricing of electricity as they emphasize future economic signals rather than relaying on financial signals based on today's performance and historic financial costs.
- **Border Prices:** This approach is applicable to traded energy such as petroleum products and involves comparing domestic prices to border prices – that is, import or export parity prices – together with taxes and transmission and distribution (T&D) costs.
- **Cost of Alternative Fuels:** This approach is based on a comparison of the actual price of an energy product, such as natural gas, to the economic or market cost of an alternative fuel, such as LPG or kerosene.

The social and economic benefits of quality energy services are well recognized. Rural people want electricity for lighting, as this provides the ability to extend the day. In addition, children can study longer hours, which will raise educational levels in the long run. Energy subsidies and other interventions to stimulate rural energy markets may be justified because the welfare gains – either from the benefits of additional energy services or through the reduction of cash expenditures on energy – often are much higher than the long-term costs involved in providing modern energy service. Left to their own devices, however, free markets in energy services do not always work effectively. In particular, they do not take account of social and environmental benefits and costs that might be associated with certain types of energy activities.

Specifically, the prevalence of the following market barriers provides a justification for rural energy subsidies:

- The up-front investments required to reach rural customers and the small ensuing revenue flows do not attract many businesses or service providers, especially those with short-term profit goals.
- The poor often lack the means to pay for these long-term costs at the initiation of service or over a short-term period. As a consequence, the service provider – whether public or

private – has little incentive to market energy services to poorer segments of the population.

- In countries that do not have facilitating policies, the rural and poor are likely to be precluded from the benefits of modern energy.

Hence, to overcome the existing market distortions, some form of subsidy may be required to assist poor households in obtaining higher quality energy services, either by providing direct subsidies to the poor or, where service networks are non-existent, by providing incentives to businesses to develop such networks. Subsidies may also be used to enable some groups to consume more of a service than they would under a pricing regime intended to recover a utility's full costs.

2.3 Types of Energy Subsidies

Subsidies can come in many different forms depending on the country's institutional endowment and on government policies. Some have a direct effect on price, like grants and tax exemptions, while others act indirectly, such as regulations that skew the market in favor of a particular fuel or technology. Alternative subsidy mechanisms may include cross-subsidies between user groups, subsidized interest rates on loans, equity investment by a government to promote service expansion, low bulk tariff rates for distribution companies expanding service, and concessional taxes and duties. Examples of subsidies existing in the energy sector include:

- Price subsidies to hydrocarbon fuels, for example cross-subsidization of kerosene through higher petrol prices.
- Price subsidies for electricity consumption, such as cross-subsidies on electricity tariffs from the commercial and industrial sector to households and from urban to rural consumers.
- Capital (or investment) subsidies for renewable energy technologies such as micro-hydro, biogas, and solar energy.

2.4 Constraints and Lacunae in the Existing Subsidy Regimes

Unfortunately, subsidies have often failed to meet their stated objectives of making services more affordable to the poorest. Subsidies have often been **implicit**, such as default or non-payment of electricity bills; **untargeted**, such as a subsidy for energy used by all; **indiscriminant**, such as a subsidy for a quantity that is well above that needed by poor or rural populations; **complex**, or difficult to administer to targeted groups; and **overly restrictive** with respect to end use or technology, depriving users of choice (Barnes and Halpern 2000). While some of the subsidies have contributed to improving rural communities' access to modern energy, many have actually left the poor worse off. There are three reasons for this (UNEP 2002):

1. The poorest households may be unable to afford even subsidized energy or may have no physical access to it, for example, when a rural community is not connected to the electricity grid.
2. Even if the poor are able to benefit from an energy subsidy, the financial value to them may be small since their consumption is generally modest. Higher income households

tend to benefit much more in nominal terms since they consume more of the subsidized fuel.

3. Consumption subsidies that involve the imposition of caps on prices below market levels may lead to a need for rationing. Middle and higher income households tend to get hold of the bulk of subsidized energy in countries where it is rationed, through petty corruption and favoritism.

Energy subsidies also constitute a huge financial drain (revenues from electricity supply in developing countries fall short of costs by some US$ 100 billion every year). Power sector subsidies in India reached Rs 280 billion, or **1.3%** of GDP, in FY 2000, with the utilities incurring losses of Rs 202 billion (World Bank 2002b). The current energy subsidy mechanisms also enable the utilities to operate at a high level of inefficiency, as government largesse does not create incentives to operate on a commercial basis.

2.4.1 Specific Problems

2.4.1.1 Stifling Private Sector Growth

One of the negative effects of subsidized programs is that they tend to undermine the development of a commercial market. Heavily subsidized photovoltaic (PV) for rural communities have had an extremely poor record (World Bank 1995). First, in subsidy program areas, households are unlikely to purchase systems at a market price if they can obtain it more cheaply through a subsidized program. Once people have obtained them, they may willingly use the systems provided, but they are unlikely to maintain them properly, repair them, or replace them. The benefits of such programs are transitory and do little to promote a self-sustaining market. In fact, by undercutting the private sector, they may actually retard the development of the PV market.

One way to overcome this conflict is to provide a general subsidy on all equipment, whether through government or private channels. This arrangement requires a high degree of control if it is not to be abused. Unless extremely carefully managed, subsidized-equipment programs can turn out to be a large and open-ended drain on government funds. They can also lead to a high degree of control by the bureaucracy and a stifling of commercial markets and competition.

Tariffs and the Indian PV Industry

In the early 1980s, the government of India set out to nurture the growth of a domestic PV industry behind a tariff wall. Government demand for PV technology led to a rapid growth of this industry. However, as suppliers of modules and complete systems were able to generate more secure revenues under the Government's PV programs, they saw little need of developing the rural market infrastructure.

Source: Miller and Hope 2000

2.4.1.2 Failure to Reach the Poorest

Subsidies have often failed to meet their stated objectives of making services more affordable to the poorest. Mis-targeting of subsidies grows as different interest groups attempt to capture the benefits accruing from such programs. For example, because kerosene is considered to be the "fuel of the poor", many governments have kept its taxation at a low level so that it remains affordable. What has ensued in reality in most cases has been quite different. In addition to distorting economic signals to consumers, the large price differential between kerosene and vehicular fuel makes adulteration an attractive proposition. Furthermore, the benefit of lower kerosene prices often does not fully reach the poor. Although many poor people are now cooking with kerosene, most of the beneficiaries are middle and higher income classes.

2.4.1.3 Poor Dimensioning of Subsidies

In some cases, subsidies for the poor are not properly dimensioned. One such case is the misuse of lifeline electricity tariffs[3]. A lifeline tariff is usually a cross-subsidy that enables poor households that use minimal services to pay a lower price than wealthier households that use higher levels of service. The advantage of properly targeted lifeline rates is that they are directed both toward the poorest households and toward that part of energy demand that provides high levels of benefits, namely initial lighting services. But in many countries, the lifeline rate is set at very high levels, which makes it extremely difficult to target clearly the poorest households. In Chad, for instance, the lifeline was fixed at 200 kWh per month, which actually encompassed well over **90%** of the population (Barnes and Halpern 2000).

2.4.1.4 Phasing out of Subsidies

Experience shows that subsidies, originally meant to encourage the development of an activity, often outlive their usefulness and eventually begin to cause problems for society. In the early stages of the green revolution, the Indian government, in order to promote irrigation (and thereby food security), set very low tariffs for electricity for irrigation (Barnes and Halpern 2000). After a time, even though this practice was not really necessary, the farmers' lobby managed to keep the existing subsidies in place. In fact, in some states, it has persuaded politicians to provide free electricity to farmers. As a consequence, the state electricity boards have been severely de-capitalized and run into recurrent losses.

2.4.1.5 "Polluting the Well"

This happens especially when subsidies are tied to a particular supplier or product configuration, which gives them an unfair advantage and makes it difficult for other technologies to compete. Similarly, when subsidies are tied to a particular product specification, there is little incentive for the private sector to innovate and go beyond the subsidized product. In rural areas, subsidies often undermine the efforts of businesses to provide cheaper ways of generating electricity. In remote rural areas, for example, diesel engines or stand-alone photovoltaic (SPV) systems may provide electricity at a lower cost than grid supplies. But if grid electricity is subsidized, the consumers will not opt for them, nor will investors come forward to develop least-cost options.

[3] A lifeline tariff is a cross-subsidy that enables poor people who use minimal services to pay a lower price than more wealthy households that are using higher levels of service.

Table 2-1 Rural Energy Scenario in the Study Countries

Bangladesh	Nepal	Sri Lanka	India
Current Scenario			
▪ 15 million rural households ▪ Low per capita energy consumption (63 kWh annually) ▪ **15%** of rural households (and **30%** of total) connected to the grid ▪ Rural electrification through independent consumer-owned cooperatives ▪ Limited experience with solar home systems ▪ Recently launched World Bank supported Rural Electrification and Renewable Energy Development Project (RERED) to: (i) provide additional 700,000 connections through grid-based systems; (ii) provide 64,000 off-grid electricity connections; (iii) develop a framework for pilot projects to implement small power projects	▪ More than **85%** of the households living in rural areas ▪ More than **80%** of the households using fuel wood as their primary energy source ▪ Less than **5%** rural households connected to the grid ▪ High cost of grid connection (more than US$ 10,000 per kilometer) ▪ 4,000 MW of hydropower potential, 300 MW developed so far ▪ Over 2,000 SHSs installed so far under government subsidized program. ▪ Renewable energy subsidies administered through AEPC, supported by DANIDA	▪ Low per capita electricity consumption (247 kWh annually) ▪ **90%** of rural households use biomass for cooking ▪ **70%** of power generation from hydro electricity ▪ **47%** of the population do not have access to national grid ▪ 60,000 to 80,000 houses are connected by the grid every year, the average rate of grid expansion being **2%** per year ▪ Over 130 village hydro projects implemented so far ▪ 28,000 SPV systems installed by the private sector using dealers and retail sales centers public institutions	▪ More than **70%** of the population living in rural areas ▪ Low per capita consumption (350 kWh) ▪ **90%** of rural households use biomass for cooking ▪ **85%** of villages connected by the grid, but **37%** of rural households have electric connections ▪ Special Ministry of Non-Conventional Energy Sources
Policy Vision			
▪ Universal access by 2020 to over **70%** of nearly 15 million rural households ▪ Supplement grid-based electrification with off-grid options	▪ Nepal Electricity Authority plans to connect **30%** of national households to the grid by the year 20	▪ CEB is planning to achieve **90%** coverage of the population with electricity from the main grid by 2010	▪ Energy policy in India focuses on "electricity for all by 2012": all villages by 2007 and households by 2012 ▪ **10%** of the capacity addition in total power generation by 2012 will come from renewables

3.1 What the Rural Customer Wants

Given existing rural energy scenarios and the relatively limited success of traditional subsidies, it is clear that the energy service requirements of the rural customer must be better understood. Even though variations arise from factors such as traditional fuel resource availability (including access and control issues), availability and price of commercial fuels, and status and quality of electrification, experience suggests that rural customers want

- A predictable supply (not necessarily 24-hour)
- About 10 to 30 kWh per household per month[4]
- Affordable prices with payments consistent with local income patterns
- Energy for specific uses (e.g., water for irrigation, mechanical shaft power for milling)

3.2 What the Rural Customer Can Afford

The issue of affordability for energy services must be viewed not in the context of whether people can or cannot pay, but rather in terms of "how" and "how much". Evidence suggests that people will spend a significant proportion of their incomes on better energy, which improves their quality of life or enables them to become more productive. The problem is that rural customers often cannot get affordable credit, which makes it difficult for them to pay the high initial costs of improving their energy supplies. While the wealthiest members of rural society may be able to afford cash sales, the paying ability of low-income households depends on the availability and terms of financing. There are many examples of service providers and financial institutions developing innovative delivery mechanisms for rural energy service provision that offer a range of payment mechanisms. Some of these examples are discussed in more detail in subsequent sections.

Constraints to Providing Term Finance in Rural Energy

- Unfamiliarity of the lenders with the technology
- High transaction costs relative to the size of loans
- Inadequate collateral
- Borrowers with no credit history
- Limited or lumpy cash flows

3.3 Design Principles for Subsidies for Rural Energy

To be cost-effective, efficient, and useful for rural and poor people, energy subsidies should have two main goals:

1. To assist the poor in gaining access to higher quality energy services.

[4] Where lighting is the only significant use of electricity, monthly consumption tends to be in the range of 10 to 20 kWh monthly (Foley 1995). Two 40 W incandescent bulbs used for five hours each night, for example, have a monthly consumption of 12 kWh. A radio cassette player and a small fan can be used for 10 hours each day for an additional consumption of 10 to 15 kWh per month. A small color TV used for six hours a day will add a further 10 kWh a month.

2. To provide business incentives to serve rural and poor consumers. In the past, private companies have shied away from entering rural energy markets because of financing constraints, regulations that prohibited or encumbered development of local grids, poor pricing policies, and government taxation on energy products.

Experience shows that subsidy programs should be:

- **Well-targeted.** Subsidies should go only to those who are meant and deserve to receive them.
- **Efficient.** Subsidies should encourage provision of service at least cost and not undermine incentives for suppliers or consumers to provide or use a service efficiently.
- **Cost Effective.** Subsidies should help achieve social goals at the lowest program cost while providing incentives to businesses to serve rural populations.
- **Practical.** The overall amount of the subsidy should be affordable and the administration of the subsidy program should be at a reasonable cost.
- **Transparent.** Information on the amount of government money spent on the subsidy and on subsidy recipients should be disclosed and cross-subsidies should be explicit.
- **Time-bound.** Sunset clauses should be included in the design of subsidy programs to avoid consumers and producers becoming overly dependent on this support and costs spiraling out of control.

3.3.1 Whom to Subsidize

It is important to target subsidies because subsidizing all rural households in a region may not be financially feasible. Further, the priority of poorest households may not be energy but other basic commodities, such as food and clean water. As a general rule, in developing countries subsidies should be directed at those currently without access to higher quality energy services and not already connected to the distribution network. In the case of electricity, the share of the population without service varies significantly, from **10%** to **40%** of the population. Households that already have service are generally the better off.

Subsidies for rural energy should thus focus on two categories: (1) households for whom modern energy is a high priority and (2) the poorest existing customers, whose consumption is very small because of high prices and low incomes.

The subsidy questions... Who?
- Households for whom energy is a high priority
- Poorest customers with low energy consumption

3.3.2 What to Subsidize

In general, it has been suggested that subsidies should be applied to access or connection costs – not to operating costs or on-going consumption (see Figure 3-1) (Barnes and Halpern 2000, World Bank 1995, Del Rosario undated). Subsidizing some of the access barriers encourages the poor to climb the energy ladder. For example, the electricity connection fee for poor households can be kept low by providing a partial subsidy for the capital costs of a connection and, perhaps, rolling the rest of the cost into monthly bills. An example of such a subsidy program is Chile's rural electrification program, where subsidies are provided to rural communities for the capital costs of acquiring electricity service. Once the aggregate level of subsidy is decided, it is up to the municipalities in each region to distribute these subsidies to eligible households, which is undertaken using a "poverty score." In Argentina, municipal authorities pay for energy utility connection investment provided to low-income areas like slums. A levy on the utilities funds part of the electricity bills and service extensions for the poor.

The subsidy questions... What?

- Subsidize initial cost of access
- Lifeline tariffs for lowest levels of consumption

A more market-oriented approach involves not direct funding of connections, but explicitly considering a financial policy on connections as a part of the overall rural energy policy. More specifically, connection is best dealt with through the provision of accessible rural credit (Pearce and Webb 1987). This strategy leaves the decision in the hands of the consumers, who will secure credit to obtain connections only if they are convinced about a net financial benefit from connection.

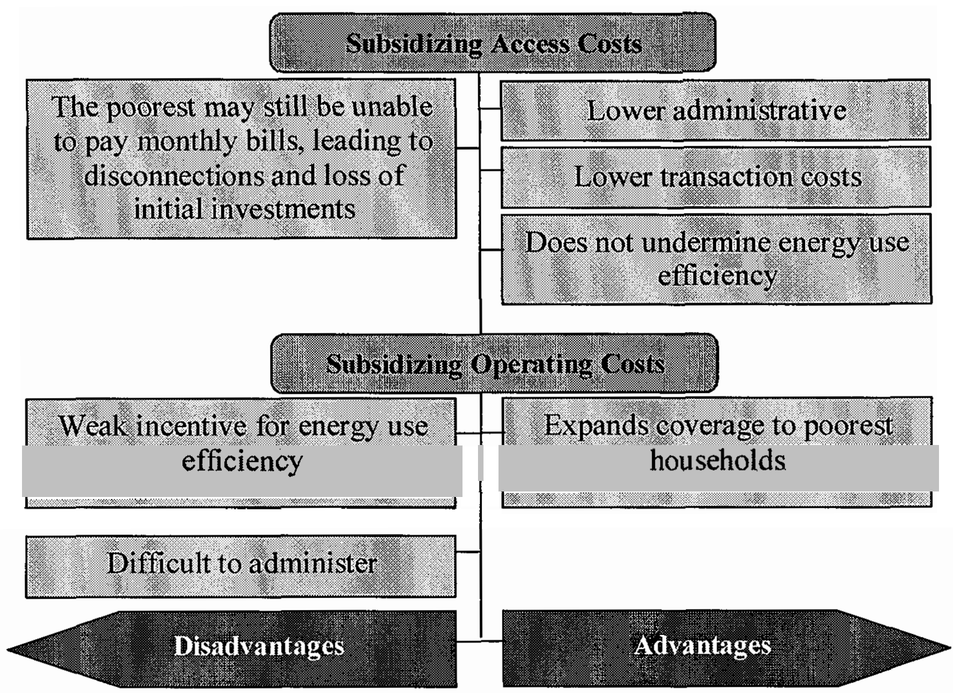


Figure 3-1 Access versus Operating Cost Subsidies

For both new and existing customers, it may be necessary to subsidize the actual supply of electricity through lifeline rates for poorer households.

Subsidies for Access

Subsidies for access can reduce business costs in a rural service territory. It can be quite costly to extend electricity to one household in a village. But if service initiation costs are low, perhaps 100 households would be encouraged to take a connection and start paying monthly electricity bills. While a business could not make any profit serving one household, its likelihood of making profits is definitely higher while serving 100 households.

3.3.3 How to Subsidize

The choice of instrument and implementation mechanism is a significant determinant of the efficiency and efficacy of a subsidy in improving the welfare of the poor. In general, demand-side subsidies involving partial funding of connections work better than fuel or supply-side subsidies because they have better targeting properties and provide stronger incentives for expanding coverage and sustaining services (see Figure 3-2). The downside of demand-side subsidies is that they require an administrative and institutional superstructure to identify and verify target beneficiaries independent of the service provider. Supply-side or fuel subsidies, such as the kerosene subsidy in Indonesia, have poor targeting characteristics and provide weak incentives for efficient service delivery.

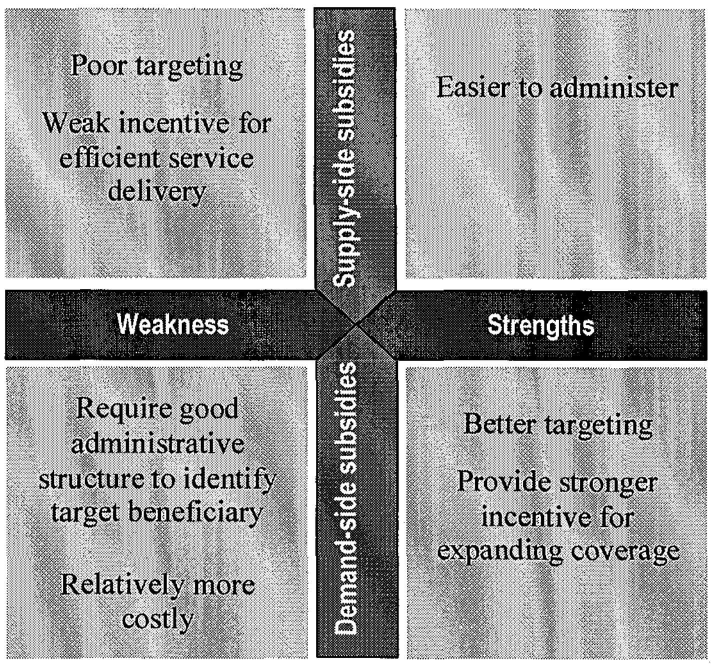


Figure 3-2 Supply- versus Demand-side Subsidies

In a few countries with strong administrative capability, supply-side subsidies (cross-subsidies and under-pricing the bulk "commodity") have not unduly undermined the financial viability of the businesses involved. One example is the rural electrification program in Thailand. The subsidy was important for expanding electricity to more than **90%** of the population, and the Thai program was sustained because of the many measures taken to keep costs low and to safeguard the financial viability of the service providers.

The subsidy questions... How?

- Demand side subsidies work better, but are more difficult to administer
- Offer subsidies to multiple service providers
- Make subsidies technology neutral
- Base producer subsidies on per unit of output

There is a fine line between subsidies that encourage service provision and those that encourage only the purchase of equipment. This is an especially important problem for renewable energy, since most of the costs of service are the capital costs of the systems themselves. The government subsidized photovoltaic program in India encouraged manufacturers to produce for the government subsidy rather than for the market.

A key issue for producer subsidies is whether to subsidize capacity or output. The answer depends to some extent on the type of fuel or technology. For example, subsidies to solar photovoltaic and wind power have been effective in boosting capacity in several countries, including Austria, Denmark, Germany, Japan, and Sweden. A supply-side grant per system sold is extremely beneficial to the development of the market infrastructure – it attracts new players to the market and it allows participating companies to expand. Moreover, when there is competition, there is pressure to pass on the grant to the consumer. But these subsidies do not always ensure that these systems, once installed, are run optimally. In general, producer subsidies should be based on per unit of output. Fixed, subsidized tariffs for renewables-based power producers may be the best way to encourage both investment and efficient operation.

In some cases, it may be practical to provide direct incentives to electricity companies to expand their services to targeted customer groups. It has to be recognized that certain consumers will not be able to pay the economic price. In general, no investor or service provider would be willing to take on the burden of such consumers unless adequately compensated by some other source. To safeguard the interests of marginal customers, it may be necessary to specify investment targets in the contract with the service providers. These targets specify the geographic area or the type of consumer who should benefit.

3.3.4 How Much to Subsidize

In principle, subsidies should be large enough to provide an incentive to distributors to extend service to poor households that would otherwise not receive it without creating unnecessary market distortions. This subsidy size will depend on local market conditions. Lifeline rates, if used, should be limited to modest levels of consumption – less than 50 kWh per month in most cases (below 45 kWh for urban and 25 kWh for rural) – so that poor households get most or all of the benefit (World Bank 1995). This way, larger consumers would be obliged to pay the full cost/tariff for the whole of their electricity consumption, denying them any access to subsidized electricity. If the rate is applied to the first tranche of consumption regardless of capacity with full cost-based rates applied to higher levels of consumption, richer households benefit to the same extent in absolute terms as poor households.

3.3.5 Tariff Policy

The tariff policy should be based on the following guiding principles (Brook 2000):

- The tariff structure should be based on sound commercial principles, and take into account a commercially based allocation of costs among consumers according to the burdens they impose on the system.
- Assurance of a reasonable degree of price stability.

- Provision, where economically feasible, of a minimum level of service to low-income consumers.
- Power prices that generate sufficient revenues to meet the financial requirements of the sector.
- A tariff structure simple enough to facilitate metering and billing.

4.1 The REB Model, Bangladesh: Rural Electric Cooperatives

The rural electricity program of Bangladesh is operated by independent consumer-owned cooperatives, *palli bidyut samities* (PBSs), functioning under the umbrella of an apex organization, the Rural Electric Board (REB)[5]. Out of 70 cooperatives envisioned to cover the entire country, 67 have been established, 57 of which are operational. About 20 million people in rural areas now have access to electricity through the three million connections. Electrification is now proceeding at the rate of 390,000 new connections annually – averaging more than 1,000 per day. The REB is fully responsible for all aspects of rural electrification. It identifies areas that are to be electrified and then sets up the rural electrification cooperative society, which is made responsible for the administration, maintenance, and financial management of the supply system. The REB is also responsible for organizing new PBSs and initiating development in project areas; planning and designing the distribution network of the PBSs and constructing the sub-station and electric lines; negotiating funding for the overall program[6]; and monitoring the performance and functioning of the PBSs. The PBSs are non-profit organizations owned by their members, who are also the consumers of electricity.

Within each PBS, the distribution network is designed on the basis of "area coverage rural electrification" (ACRE), a distribution strategy that differs from the usual practice of running lines only to economic growth centers. The supply area of each cooperative covers in general 1,000 to 1,500 square km, with 15,000 to 30,000 consumers, and includes some 800 to 1,500 km of distribution lines.

The REB model has successfully instituted and enforced a number of organizational systems and procedures that have been instrumental in attaining high levels of operational efficiency. The key instrument that tracks and monitors PBS performance is the performance target agreement (PTA), which is negotiated annually between each PBS and the REB, based on performance data from the previous year. Targets are set in up to 21 key areas including system loss, accounts receivable, revenue per kilometer of line, cost control, efficient load management, annual growth in consumers, annual growth in electrical consumption, and payment of debt service liability. Each target is assigned a weight factor, which may vary according to the equity and age of the PBS. Employees of PBSs that perform well relative to their targets are rewarded with pay bonuses of up to **15%**, while employees of PBSs with poor performance receive either no bonus or a **1%** penalty.

4.1.1 Subsidies and Financial Mechanisms

There are essentially four levels at which subsidization is taking place in the REB-PBS operations:

[5] Sources: Murphy, R., Kamal, N., and Richards, J. 2002; NRECA 2000; Prokaushali Sangsad Ltd, 1998; Zomers, A. N., Bosch, H. 2000

[6] REB manages all international donor assistance to Bangladesh for rural electrification. Over the past 24 years, REB has been able to draw upon more than US$ 1.1 billion in financing from some 17 donors and the government. More than US$ 200 million have been invested by USAID alone, which provides long-term support for NRECA technical assistance.

4.1.1.1 Purchase of Subsidized Power

The PBSs currently purchase electricity from the DESA and the BPDB at wholesale rates of Tk 2.12 and Tk 2.05 per kWh, respectively (World Bank, personal communication), paying significantly less than regular industrial consumers.

4.1.1.2 Provision of Subsidized Finance to PBSs

The PBSs receive financial support from two sources: a significant proportion comes from donors, and this is matched by contributions from the government. Donor loans are transferred from the government of Bangladesh to the REB at an annual interest rate of **2%**, with a long repayment period and a grace period before repayment begins. In turn, the REB extends loans to the PBSs at a rate of **3%** over 30 years, retaining the **1%** as a margin to cover central program management costs. Earlier, the ratio of donor to government funds was 80:20; over the years, the local contributions have increased, making this ratio 60:40 (REB personal communication).

4.1.1.3 Direct Subsidies to Loss-making PBSs during Start-up

By the very design of the program, it is expected that revenues of a PBS may fall short of expenses during its initial years of operation. Accordingly, for the first five years following energization, PBSs are not required to make principal payments on loans provided by the REB. Moreover, the interest charges for the initial five-year period are assessed at a reduced rate of **0.75%** rather than the **3%** program standard and are capitalized into the investment cost of the original loan (NRECA 2000) during this period, REB subsidizes the PBSs by taking care of their operational losses, which are budgeted into REB's annual budget as planned deficits. Currently, 10 PBS are being subsidized in this manner.

4.1.1.4 Cross-subsidization of the Domestic Sector from Industry and Commercial Sectors

The tariff structure cross-subsidizes domestic and agricultural consumers by levying rates on them below the cost of service and levying rates above the cost of service on industrial and commercial consumers. Virtually all domestic connections have consumption below 300 kWh per month and more than **80%** fall into the lowest tariff category.

4.1.1.5 Cross-subsidization across PBSs

REB has instituted a revolving fund, to which all PBS that are performing well make a contribution, which is used for assisting other PBSs, the financial performance of which is not up to the mark.

Subsidies Operating in the REB-PBS Model

- Purchase of subsidized power from state utilities at wholesale rates
- Provision of subsidized finance to PBSs through low-interest loans and long repayment periods
- Direct subsidies to loss-making PBSs during start-up years, which are included in REB's annual budget as planned deficits
- Cross-subsidization of the domestic sector from industry and commercial sectors
- Cross-subsidization for loss-making PBSs from a common revolving fund

4.1.2 Electricity Tariffs and Connection Costs

Retail tariffs charged by the PBSs vary and are approved by the REB. The tariffs are set in an attempt to balance the perceived ability of the PBS customers to pay for electricity service and the need for the program to sustain itself economically. The tariff structure cross-subsidizes domestic and agricultural consumers by levying rates on them below the cost of service and levying rates above the cost of service on industrial and commercial consumers (Table 4-1). Currently, **84%** of the customers fall in the lowest bill category (Tk 70 per month) consuming less than 20 kWh of energy per month (REB personal communication). Usually the PBS tariff is **40%** - **60%** higher than normal average tariffs charged in urban areas.

Table 4-1 Tariff Structure as of January 2002

Domestic (kWh)					Commercial			Irrigation	Small industries			Non-residential (light & power)
100	101-300	301-500	501-700	>700	Flat rate	Off peak	Peak hours		Flat rate	Off peak	Peak hours	
Taka per kWh												
2.26	2.42	3.62	4.73	5.99	5.04	3.62	7.82	1.84	3.83	3.05	5.36	3.2
US cents per kWh												
3.93	4.2	6.29	8.22	10.4	8.75	6.29	13.58	3.2	6.65	5.3	9.31	5.56

Source: World Bank personal communication

To secure a residential connection, an individual must pay a membership fee and a security deposit and must also cover the cost of house wiring (Table 4-2). If the new connection is beyond 100 feet from an electric pole, additional line extension charges may apply (Murphy, Kamal and Richards 2002).

Table 4-2 Costs Associated with a New Residential Connection

Item	Tk
Membership fee	20
Security deposit	150
House wiring	600-1,000
Total	770-1,170

4.1.3 Recent Strategy Changes

While REB has been able to extend electricity to a large number of rural households, over **80** %of people in rural Bangladesh still lack access. This is critical, because despite high urban growth rates, four out of five people still live in rural areas. Penetration rates for residential customers vary greatly but seem to level off in most cases at **30%** of the available households. Against this background, key rural electrification issues include balancing the increasing costs of grid expansion with the need to expand rural access by rationalization of existing distribution systems; improving revenue generation, operational efficiency, and the sustainability of less viable PBSs; and finding viable off-grid alternatives, in addition to the grid-based supply, so as to increase electricity penetration in rural areas. In order to meet these challenges, REB has initiated several strategy changes, aimed at enhancing the efficiency of operations and improving coverage. The key changes are as follows.

4.1.3.1 Rationalization of Distribution Networks through Take-over from Other Utilities

With respect to transfer of areas from other utilities, the government has now established a more rational policy, whereby all pocket areas, including municipalities with up to 3 MW loads, are to be transferred to the PBSs (World Bank 2002a). In addition, transfers are to take place on an economic basis, allowing entire lines and associated facilities in a pocket area to be transferred in one package as opposed to fragmented hand-overs.

4.1.3.2 Enhancing the Financial Viability of PBSs

It is now being recognized that that all PBSs cannot be expected to generate sufficient revenue in early years of operation. REB has put in place a number of mechanisms to rationalize the variable performance of PBSs:

- Cash-flow subsidies will be provided for a period up to six years with annual reviews to determine the level of need of each PBS. For this, REB uses a standard method to evaluate the subsidies taking into account the number of years the PBS has been in operation, number of customers it serves, system losses, and collection rate
- Until now, REB has been applying uniform financing terms for all PBSs. This will now be made variable (with the interest rate varying between **0%** and **5%**), depending on variables like remoteness, accessibility, and level of economic development. For PBSs that are operating in adverse conditions, the moratorium period will be increased to six years
- The financial viability of PBSs will also be addressed through a other measures, including, revenue enhancing measures such as actions to transfer pocket areas and critical load centers from BPDB; selective investments that could enhance revenue and performance profiles; and expanding productive uses of electricity to increase consumption patterns

4.1.4 Achievements

The REB-PBS set-up has made significant strides in rural electrification, extending electricity to over 37,000 villages and establishing almost four million connections. To supply this vast consumer base, over 149,935 km of distribution line have been constructed and energized, served by 260 33/11 kV sub-stations (REB 2003).

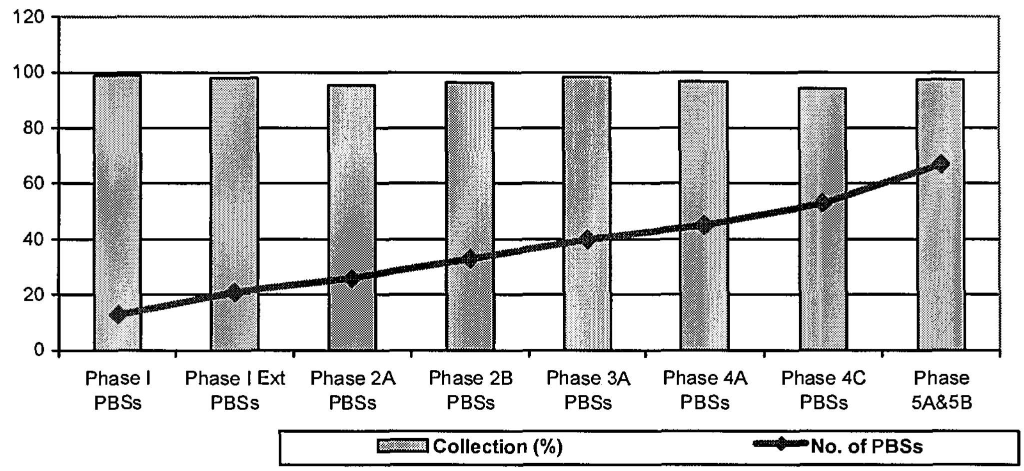


Figure 4-1 Collection Performance of PBSs[7]

However, in the context of the government of Bangladesh's commitment to extend the electricity infrastructure to all corners of the country before 2020, the existing penetration rates will have to be improved significantly. At the present electrification rate of 200,000 connections a year, only about **22%** of the households are likely to have a connection to the rural grid by 2010 (Zomers and Bosch 2000). It is clear that given the low level of coverage (fewer than **25%** of rural households have access), electrification rates have to increase dramatically to make a significant dent in the rural energy scenario.

4.2 Singur Haripal Rural Electric Cooperative Society, India

4.2.1 Background

In India, the formation of rural electric cooperatives for distribution of power in rural areas started in 1960s. In 1969, five pilot rural electric cooperative societies (RECSs) were established and the Rural Electrification Corporation (REC)[8] took the responsibility of funding and promoting rural electric cooperatives. During the 1970s, REC extended loans to set up RECSs at low interest rates and long repayment periods (**3%** for 25 years). Currently, the loans are given at **7%** with a moratorium of 10 years.

Over the years, a total of 41 RECSs spread over 12 states were registered. Only 20 of these, however, are still in operation, while 17 since then have been taken over by the state electricity boards (SEBs). In all, RECSs have electrified 4,175 new villages against a planned coverage of 4,251 un-electrified villages.

[7] Source: REB 2003

[8] Rural Electrification Corporation (REC), a wholly-owned government of India public sector enterprise, set up in 1969 under the Companies Act, 1956. REC's main objective is to finance and promote rural electrification projects all over the country. It provides financial assistance to state electricity boards, state government departments, and rural electric cooperatives for village electrification and energization of pumpsets.

Table 4-3 Achievements of RECSs up to March 2002

Physical Works	Targets	Achievements	Percent
Villages	4,251	4,175	98
Agricultural services	154,636	266,597	172
Domestic/commercial services	488,276	1,055,315	216
Industrial services	14,741	24,937	169

Source: REC Personal Communication

The primary objective of the RECSs is to cater to all loads up to 74 horsepower (hp) with due weight to agricultural energization programs in rural areas. Typically, RECSs operate in remote, hitherto un-electrified pockets, with a high proportion of domestic consumers and extremely low industrial and commercial loads. The RECSs are registered under the Cooperative Societies Act, which defines the bylaws, membership requirements, and operating rules. The RECSs purchase power from the SEBs at bulk rates. Unlike Bangladesh, however, where the PBSs bulk-purchase power at subsidized rates, in most states in India the RECSs are treated at par with other bulk consumers of power and do not enjoy special provisions. Typically, the SEBs being large utilities like to keep control of the entire process of generation, transmission, and distribution and provide minimal support to the RECSs once they are set up and operational. The societies are overseen by a board of directors elected by their members in accordance to their bylaws.

A previous Nexant SARI/Energy study, which studied two RECSs (The Cooperative Electric Supply Society Ltd, Sircilla in Andhra Pradesh and Singur Haripal Rural Electric Cooperative Society, Ltd, in West Bengal), revealed that the two RECSs are well run rural electricity distributors (Nexant SARI/Energy 2002).

Subsidies Provided to Rural Electric Cooperatives, India

- Provision of subsidized finance to rural electric cooperatives through low-interest loans and long repayment periods
- Cross-subsidization of the domestic sector from industry and commercial sector

4.2.2 Profile of the Singur Haripal RECS

The Singur Haripal cooperative, which was set up in 1978, covers the two *thanas* (police stations) of Singur and Haripal, nearly 70 km from the state capital of Kolkata. Under the existing Electricity Act of West Bengal, Singur Haripal does not require a license to operate as a RECS. At the time of setting up, the assets of the West Bengal State Electricity Board (WBSEB) assets were handed over to the cooperative at the depreciated value of Rs 59.5 lakhs, on the condition that **50%** of this amount would be paid back to the SEB, and the balance would be converted to equity. The cooperative also received loan assistance of Rs 99.608 lakhs from the REC and financial assistance for two subsequent expansion projects.

Singur Haripal operates as a cooperative, with the electricity users as members. It is governed by eight directors, who are elected from among the members, three government nominees (one each from REC, WBSEB, and an employee representative), and an ex-officio managing director. The day-to-day operations are taken care of by staff appointed by the board, while key issues, including strategic decisions and interaction with state and central government agencies, are taken care of by the board members.

4.2.3 Financial Performance of the Singur Haripal Cooperative

Right from inception, the cooperative has been operating in a scenario in which the bulk power rate was subsidized and it had the freedom to set the tariff for its consumers. With good management practices, the financial performance of the cooperative has been good and it has been breaking even. The current value of the cooperative's assets is Rs 2,049 lakhs. As on March 2002, its share capital Rs 4,645,400, with WBSEB's share of Rs 35 lakhs, members' share capital of Rs 1,145,400. Till now, there have been no defaults in the cooperative's loan repayment to REC. Currently, the amount outstanding to REC is Rs 34,554,928, which requires a quarterly payment of Rs 7 to 7.5 lakhs. The interest saved on the REC loan during the five-year moratorium period has been utilized to create a Special Reserve Fund (SRF), which has been earmarked for specific system improvement purposes, and only after prior approval of the REC. This fund has grown significantly over the years, and stood at Rs 2,044.59 lakhs in May 2002. The cooperative has dipped into the SRF only once so far.

The situation, however, changed in 2000-01, when the West Bengal Electricity Regulatory Commission (WBERC) introduced changes in the power purchase rates and the final consumer tariff. The cooperative incurred a financial loss for the first time in 2001-02. The bulk power purchase had been set at 13.02 paise per unit in 1980. In 2000-01, WBSEB submitted a tariff petition to the WBERC, requesting an enhancement of the consumer tariff as well as the power purchase rates for the cooperative, following which the power purchase rate was increased to 90.35 and 98.35 paise per unit for 2000-01 and 2001-02, respectively. For 2002-03, SEB proposed Rs 2.00 for bulk rate for Singur Haripal, which is the bulk rate for all commercial consumers[9]. The WBERC further directed the cooperative to sell power to all consumers at a flat rate of Rs 1.38. This translates into an average revenue of Rs 1.71 per kWh sold for 2000-01 and Rs 1.72 for 2001-02, which is less than the average cost of supply Rs 1.79 per kWh. The cooperative is currently purchasing power at 79.35 paise per kWh.

[9] This decision was in line with a Supreme Court ruling that directed state governments to stop cross-subsidizing among the same category of users and treat all entities at par.

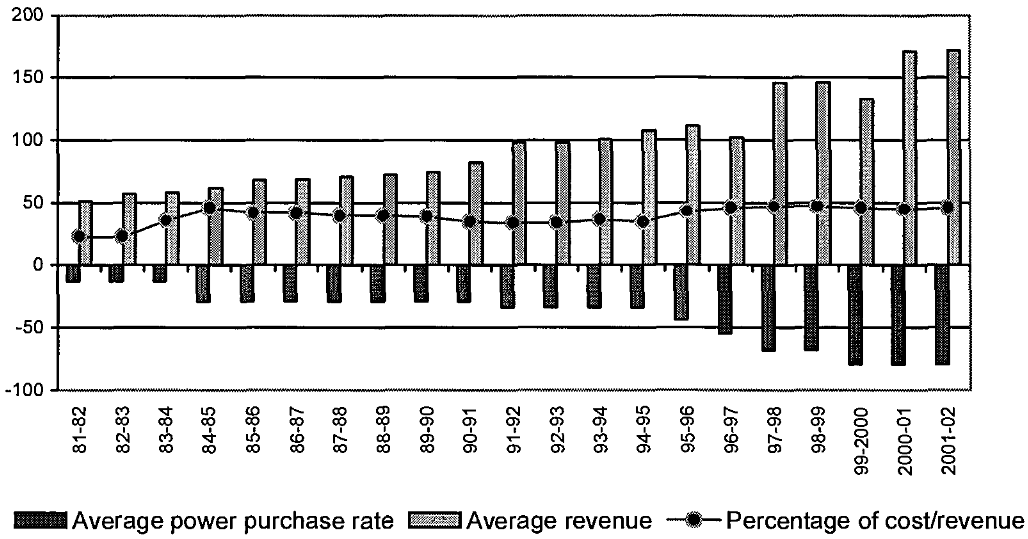


Figure 4-2 Cost of Power versus Average Revenue of Singur Haripal

For the Singur Haripal RECS, the above changes have two direct implications for consumers and for its own operations and survival:

1. **Additional Financial Burden on Consumers:** Currently, the biggest predicament the management is facing is the flat rate tariff will mean a substantial increase in the cost of power to be paid by the lower end consumers (including *Kutir Jyoti*[10] households). Further, as the change is to be retrospective, arrears will have to be collected from the lower end consumers, and refunds given to the higher end consumers
2. **Need for Installation of Meters:** If a flat rate tariff has to be introduced, all consumers will need to be metered. Till now, categories operating at the lowest tariff level as well as irrigation were not being metered. Installing meters for them means an additional expenditure of Rs 5 crores and two to three years

4.2.4 Achievements

The Singur Haripal cooperative has made commendable progress over the years, both in terms of expanding the consumer network as well as collection rates. The cooperative started with the existing 4,000+ consumers of the WBSEB in the two thanas. In March 2003, the number of consumers stood at 82,853 in 440 villages (Figure 4-3). The Singur Haripal members expect that if they can maintain the quality of service, the number of consumers is likely to increase up to 100,000, after which it is likely to level off. It also supplies power to 22 cold storages, which store potatoes[11] and run from February through October.

[10] Kutir Jyoti is a government-sponsored program in India intended to provide electric light to people living below the poverty line.

[11] Singur Haripal falls in the Hooghly basin, which has good rainfall and soil, and is an important vegetable growing pocket.

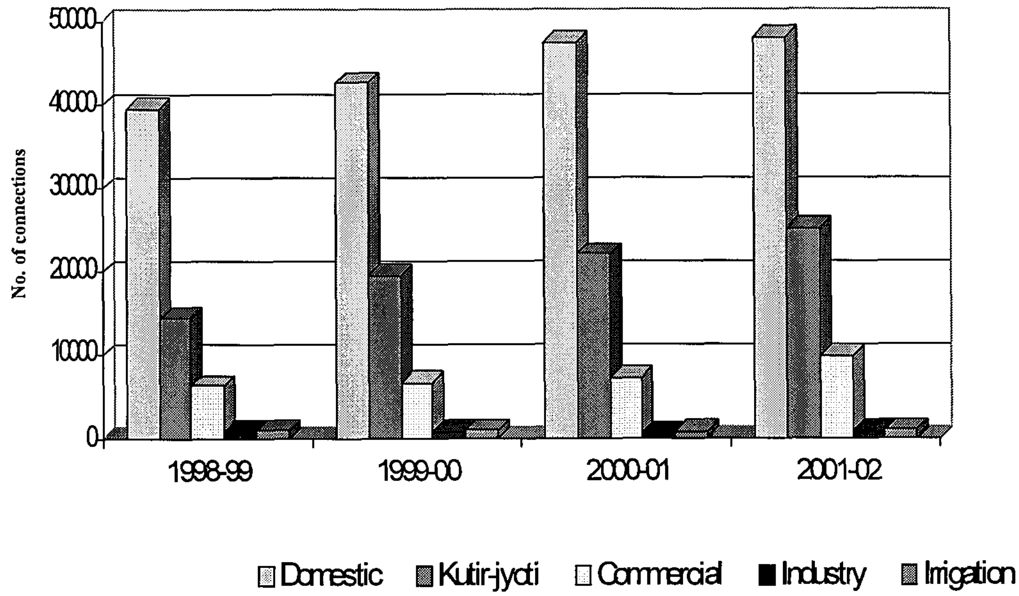


Figure 4-3 Category-wise Growth in Number of Connections

Singur Haripal has an installed capacity of 33 MW, with a peak load of 38 MW, and a daytime load of 15 MW. When the cooperative started operations in 1980, it had 156.42 km of low-tension (LT) lines, and 195.9 km of high-tension (HT), which have since then been increased to 1,011.63 km and 517.6 km, respectively.

4.3 Dissemination of Solar Home Systems, Sri Lanka

4.3.1 Background

In Sri Lanka[12], **30%** of the households are powered by grid electricity, but 2.31 million households are still without grid connection, **60%** of which can afford US$ 350 solar home systems (SHSs). The market for SPV is, however, fraught with constraints typical of any developing country: remote locations, dispersed markets, high cost of doing business, and reluctance of the urban-based banking system to lend in rural areas.

The World Bank's Asia Alternative Energy Unit and the Sri Lankan government supported the Energy Services Delivery (ESD) project between 1997 and 2002. The objective of the credit component of the project was to provide medium- and long-term financing to private sector firms, NGOs, micro-finance institutions (MFIs), and community cooperatives for grid-connected mini-hydro projects (typically less than 5 MW), off-grid village hydro schemes, SHSs, and other renewable energy investments and energy-efficiency/demand-side management investments.

[12] Sources: Gunaratna 1998, Martinot et al 2000, Nagendran 1999 and Allderdice et al 2000.

4.3.2 Financing for SPV under the ESD Project

The credit component of the ESD project is executed by an administrative unit located within the Development Finance Corporation of Ceylon (DFCC) Bank, Sri Lanka. The US$ 23.5 million credit has two components: 19.7 million as a credit from the International Development Agency (IDA) and a 3.8 million grant from the Global Environment Facility (GEF). The IDA credit is a loan to the government of Sri Lanka and is given as 10-year loans to enterprises for investments in renewable energy through a refinancing scheme, administered through what are known as the participating credit institutions (PCI).

At present, DFCC Bank, National Development Bank, Hatton National Bank, Sampath Bank, Commercial Bank, and Sarvodaya Economic Enterprises Development Services (SEEDS) participate in this credit program. The credit line provides **80%** refinance with 10-year repayment and maximum of five-year grace period. The GEF grant, on the other hand, is used for a co-financing scheme and is given as a capital subsidy (US$ 70 for system capacities of 20 to 30 Wp, US$ 100 for 30 to 45 Wp, and US$ 150 for more than 45 Wp) to reduce the initial cost of solar systems. The subsidy is released once the supplier submits a customer acceptance certificate to DFCC. Typical system size in Sri Lanka is 40 Wp. The project also covers other costs such as consultant services for off-grid village hydro and SHS and investment project preparation.

ESD Financing

Under the ESD system, the PCI designs the consumer loan package for end users, which includes an initial down payment, followed by monthly payments, usually spread over two to four years. The PCI screens applicants, executes loan agreements, and pays dealers/developers for SHS installed on households. Dealers/developers conduct market studies and sales promotion to identify potential customers, install SHS, and collect the down payments on behalf of the PCIs

4.3.3 Alternative Models for SHS Dissemination

4.3.3.1 Consumer Financing by Dealers

Under this arrangement, a PCI provides a term loan to the SHS dealer. The dealer performs marketing, technical support, and consumer financing functions. This approach, however, did not work well as most dealers found consumer financing unmanageable. Suppliers found collections too difficult and time-consuming.

4.3.3.2 Fee for Service

The fee for service model was attempted by one dealer, but was not successful. The dealer provided 140 systems on a fee-for-service basis, but found that the collection costs were too high and eating into the profit margin, making the activity unviable for the dealer. The dealer also found that if customers do not own the system, they will not take proper care of it, which increased maintenance costs.

4.3.3.3 Consumer Financing through MFIs

This model is currently most prevalent in Sri Lanka. The ESD Credit Program was originally designed for dealers/developers of SHS to provide the marketing and technical support as well as consumer credit. Dealers, however, soon realized that micro-credit evaluation, delivery, and recovery were specialized functions beyond their capabilities and that the success of such rural micro-credit largely depends on a rural presence, local connections, and an understanding of the people themselves. For the same reasons, the existing PCIs too were not equipped to provide consumer credit in such geographically scattered and remote locations. The ESD project thus turned to MFIs for extending SHS consumer credit, following these steps:

- The project developer/dealer approaches a PCI with a project.
- The PCI appraises the project, screens applicants, and executes loan agreements, after which it makes an application to DFCC for refinancing. The PCI/MFI pays dealers for SHS installed on households.
- DFCC instructs the Central Bank to refinance; **80%** of the loan amount can be refinanced under the ESD credit line.
- The rate of interest is a floating one and determined by the prevalent interest rates over the preceding six months. It is not regulated by DFCC.
- The PCI/MFI designs the consumer loan package for end users, which includes an initial down payment, followed by monthly payments, usually spread over two to four years.

The Sarvodaya Shramadana Society, which is one of the largest non-governmental organizations (NGOs) in Sri Lanka, is one of the PCIs and a key player in the ESD project. It has an extensive rural network and is involved in other social sectors including education, agricultural, and energy. Sarvodaya Rural Technical Services, the technical division of Sarvodaya, has been involved in SHS since its initial demonstration projects with the Solar Electric Light Fund in 1991. SEEDS is the financing arm of Sarvodaya, involved in financing SHS.

4.3.3.4 Financing through Private Finance Companies

The Finance Company (TFC) is a private company that provides funds for consumer goods in rural areas. Currently, TFC finances SHS through the local dealers of SELCO.

4.3.3.5 Financing through Cooperatives and Commercial Banks

The most prominent specialized rural lending organization in Sri Lanka is the Thrift and Credit Cooperative (SANASA). The organization has three tiers (village cooperatives, regional centers, and the country-level federation). A unique feature of SANASA is the autonomy the village-level cooperatives have in their operations. The Hatton National Bank, a commercial bank, has also started lending directly to SHS customers, with an SHS vendor, SELCO, supporting the marketing and technical sides of the operation. The potential customer has to be a bank customer or open an account with the branch. After the bank does the necessary credit evaluations, it finances **70%** of the cost of the SHS for qualified customers.

4.3.4 Other Support Mechanisms

4.3.4.1 Industry Participation in Policy Development

The ESD project supported the creation of a Solar Industries Association (SIA). Members of the association are dealers and MFIs who have proven sales records. The project provides technical assistance to the association, which interacts with the World Bank, government, and the national power utility, the Ceylon Electric Board (CEB), on matters such as rural electrification, import duty, and taxes.

4.3.4.2 Consumer Awareness and Marketing

To address the lack of awareness, the ESD project executes a generic promotion campaign on SHSs. The promotion targets end users, government authorities, community-based organizations, MFIs, and the general public. It educates end users on the advantages and limitations of SHS power, informs them about service and warranty arrangements, and about available loan schemes. A variety of communication channels are used, including workshops and demonstrations at villages.

4.3.5 The RERED Project

As a result of the success of the ESD project, the government and the World Bank have launched as follow-up program called Renewable Energy for Rural Economic Development (RERED). In keeping with the new policies of the government and the bank, there is an added emphasis on rural economic and social development. The focus of the credit is on improving access to poorer households. RERED is built upon the ESD project experience, and two major strategy changes have been effected:

Capital Subsidy (US$) for SHSs under RERED Project

	10 < 20 Wp	20 < 40 Wp	40 < 60 Wp
Year 1	40	70	70
Years 2 and 3	40	70	-
Years 4 and 5	400[1]	-	-

[1] Limited to one sub-grant per household and per system

1. **Offering Consumer Choice:** ESD project experience indicated that most sales in Sri Lanka have been of 32 Wp systems (selling for about US$ 450) and that customers desire a range of component options, including small systems (such as 20 to 30 Wp). Accordingly, the system specifications under RERED were modified to allow more affordable systems of 30 Wp and less to be eligible for GEF grants under the project. The range was also expanded to include systems for commercial applications such as water pumping and telecom. The co-financing component for producers is now being reduced as the market infrastructure is already in place

2. **Time-bound Declining Subsidies:** The subsidy structure includes declining cash grants on a sliding scale over the life of the project. The idea of declining grants is that as the project gets closer to completion, existing businesses should be able to offer cheaper systems to customers, and thus smaller grants are needed for the same levels of affordability

4.3.6 Achievements

In terms of impacts, the subsidies and financing mechanisms under the ESD and RERED projects played a catalytic role in developing the SHS market in Sri Lanka. While letting the free market operate, the project is effectively facilitating the market development process. It provides support in the form of taking care of promotional campaigns and setting technical specifications and warranty and service requirements, but the competitors are free to set prices and adopt their own marketing strategies. Further, the credit, which was used for extending long-term financing for development of the market infrastructure, has been instrumental in mitigating the initial disadvantages of doing business in remote and dispersed locations. The projects also made use of Sri Lanka's experience with rural micro-finance and involved MFIs in the SHS dissemination process. The dealer is responsible for marketing, installation, and after-sales service, while the MFI looks after the credit management functions. This helps both parties focus on the function in which they have a particular comparative advantage and helps minimize transaction costs for both.

The Uva Province SHS Experiment

In 2000, the Uva Provincial Council decided to use part of its rural electrification funds to subsidize SPV systems for off-grid homes in the province by SLR 10,000 (US$ 100) with ESD as the base. This led to an enormous increase in the number of SHSs in the district within a short time. An important outcome of the Uva initiative is the interest exhibited by other provincial councils in rural electrification and in exploring the potential of renewables. The Uva province committed itself to install 8,000 systems by the end of 2002 in partnership with private sector vendors and MFIs. Other provinces are watching these developments closely and the Sabaragamuha Provincial Council is likely to start subsidizing SHSs in the near future. In addition, a lower level of subsidy (Rs 5,000 per system) will also be tested.

The ESD project has successfully contributed to the take-off of the SPV market in Sri Lanka. A total of 18,619 SHSs, with an aggregate capacity of about 875 kW, had been installed by the end of June 2002. Solar home systems have been installed in 24 districts, with the Uva province leading with 7,138 systems. The project has also encouraged the national electric utility and the government to recognize more explicitly and incorporate SHSs into rural electrification planning and to recognize that unrealistic political promises and uncoordinated grid extension harm the market for solar home systems.

4.4 Renewable Resources Development Project, India

The Renewable Resources Development (RRD)[13] project – co-financed by the World Bank and other donors – provided valuable experience in directing the Indian renewable energy program towards commercialization. It was implemented during 1993-2001 through the Indian Renewable Energy Development Agency (IREDA), which is an autonomous non-banking financial company set up under the aegis of the Ministry of Non-conventional Energy Sources (MNES) in 1987, with the basic objective of accelerating the commercialization process of RETs.

4.4.1 The SPV Component of the RRD Project

The RRD project focused on pushing commercialization of three RETs – wind, small hydro, and SPV. The total fund allocated for the SPV component of RRD was US$ 42 million for an overall target capacity of 2.5 MWp to be achieved over a period of five years. The main objective of the program was to create a revolving fund to offer affordable credit facilities for purchase of SPV systems Loans were given to buy SPV systems in large volumes to service low-volume clients. The RRD was also aimed at encouraging the establishment of sustainable product supply, delivery, after-sales service, and financing mechanisms to support marketing of PV products; creating a favorable environment for the industry to grow; and fostering the

[13] Source: WII 2003

deployment of commercial PV systems for lighting, water supply, and other service applications.

Financial Mechanisms under the RRD Project

- Loan financing for up to **85%** of the project cost, at **2.5%** rate of interest to be repaid in 10 years, with a moratorium of one year, minimum promoter's contribution **15%**
- Fiscal incentives including concessional customs duty, excise duty exemption, and **100%** depreciation in the first year
- Technical assistance program

IREDA's interest rates ranged from **2.5% - 14%** , repayable over a period of up to 10 years. Apart from offering low-cost loans, IREDA also undertook extensive technical assistance programs to create awareness and build local capacity in various aspects of RET dissemination.

Unlike the wind and small hydro components, the SPV sector took considerable time to take off, with no projects in the first two years. It was only after the interest rate was lowered from **10.3% - 2.5%** for rural projects and **5%** for others that manufacturers and financial intermediaries started showing interest and the project picked up. The reduction in interest rates was accompanied by many relaxations in the procurement procedure, including a reduction in the required promoter's contribution (from **25 % - 10%**) and an increase in the loan ceiling from **75%** of the total equipment cost to **90%**. In many cases delays in legal clearances slowed down disbursements. The average time taken by IREDA to process applications in the SPV sector is 12 months. IREDA borrowers find the procedure cumbersome, time consuming, and slow. Most of the borrowers who are not from Delhi, where IREDA is located, feel that they are required to make several trips to Delhi even before the project is approved, which adds to the cost of the project besides consuming time.

4.4.2 Achievements

By the end of 2001, a total capacity of 2.145 MWp involving 78 projects under the SPV market development program had been commissioned as part of the RRD SPV component. In terms of total contribution, however, the RRD-funded projects formed a small proportion of the total capacity created in the country, less than **3.5%** at the end of 2001.

4.4.2.1 Finding Niche Markets

Consumers engaged in agriculture and living in electrified areas suffering from regular power cuts have been found to be potential customers for SPV products such as solar lanterns. Such initiatives under RRD, for instance Sungrace Energy Solutions in Maharashtra, have diversified the market and have been supported by better pay-back capability of consumers living in those areas.

4.4.2.2 Manufacturing Base

IREDA's outreach efforts, training, and capacity building; reduction in import tariffs; low interest; and other incentives have motivated a number of project developers to enter the SPV market as system assemblers and manufacturers. By the end of the RRD project, there were nearly 60 entrepreneurs in the market supplying various equipment. The efforts also led to reduction in cost and improvement in product quality.

4.4.2.3 Emergence of Service Delivery Models

The RRD project was instrumental in the emergence of various institutional models, which demonstrated ways to address the issue of offsetting the high front-end cost of SPV systems. The different models have enabled design of financial packages that are suitable for different types of end users, based on their ability and willingness to pay for energy services. Developing partnerships with local organizations such as rural cooperative societies, micro-finance institutions, rural development banks, and NGOs has been enormously beneficial for project developers in SPV project development, ensuring quality sales and service, cost-effective maintenance and management, and collection of revenue as well as for consumers in terms of developing innovative mechanisms to reduce their upfront costs. This section discusses three such service delivery models.

Offering Multiple Financing Options to Consumers: SELCO India

SELCO India, a for-profit subsidiary of SELCO International, supplies SHSs in southern regions of India. In 1996-97, SELCO received financial support under the RRD project. For sales beyond the cash market, SELCO has put in place a range of financing options for its consumers, in line with the customer profile and the rural credit system of the region, the key features of which are described below:

- **Tie-up with Local Financial Institutions:** SELCO has used grant money for opening high-value fixed deposits with local banks[14], and used this for buying down the interest rates (prevailing market interest) for purchasers of SHSs. It has joined with banks like the Syndicate Bank and rural development banks like the Malaprabha Grameen Bank[15] to lend for installation of SHSs to its customers. The Solar Lighting scheme of these banks offer three-to-five-year loans to consumers for **90%** of the solar system cost, at an interest rate of **12% - 12.5%** (priority sector lending rate). By doing so, SELCO has effectively outsourced payment, collection, and credit management to them, thereby minimizing its own transaction costs. The specific advantages of the mechanism are ready financing and familiarity of villagers with the bank procedures; customer confidence because of the involvement of a local bank; the bank taking on the responsibility of credit management; and faster loan processing because of presence of local branches in the villages

- **Direct Financing:** Until recently, SELCO offered customers financing directly through a World Bank line of credit. To access funds under this line of credit, SELCO had to seek a bank guarantee from a US not-for-profit company, E&Co

Basket Solar Fund

The NGO Don Bosco operates a "Basket Solar Fund" in Pavur, South India where SELCO has installed SHSs for a tribal community. The tribe members repay on a monthly basis, the installments coming from the enhanced income accruing from additional baskets woven during the extended light hours in the evenings resulting from the SHS.

- **Leasing:** SELCO offers a lease-to-own option, in which the consumer pays one fourth of the system cost as upfront payment, and the rest is a loan at **12%** interest. SELCO

[14] SELCO India has made considerable efforts in terms of educating banks about renewables and convincing them to offer lending for this sector, especially in the rural areas.
[15] Malaprabha Grameen Bank is a rural development bank with highest recovery rates in the country.

procures systems from reputed manufacturers with product guarantees. The financing is provided by non-banking financing companies, which receive tax benefits

- **Collaborating with NGOs:** SELCO works with local rural institutions such as NGOs and community-based organizations, which offer system financing for their members. Many of these offer payment schedules linked with the agricultural season

The SELCO experience of doorstep financing, involvement of local institutions, and reliable after-sales service has established them as critical factors for market growth. The main factors that seem to have contributed to its success are

- Collaboration with local financial institutions helped in gaining confidence of the people and in collection of payments
- By setting up rural branches and training local people as technicians, SELCO provides prompt after-sales service as well as in creating employment opportunities
- By operating through local independent branches, SELCO has kept the management system decentralized and simple

Leasing through a Cooperative Bank: Wahandharak India

A large number of cooperative banks in rural India are operating to meet the small credit requirements of rural people. These organizations typically extend loans worth Rs 10,000 to Rs 50,000 to their members, for purposes such as purchase of agricultural equipment, tractors, weddings, and other home ceremonies. The Wahandharak Nagari Sahakari Patsanstha Maryadit of Kolhapur district in Maharashtra state is a cooperative society, whose primary business is mobilizing savings from its 7,000 members and advancing them small loans. It helps its members save through regular deposits and has a network of collection agents who collect the amounts from the members on a daily, weekly, or monthly basis.

Wahandharak has been implementing an innovative solar lantern program, in collaboration with Sungrace Energy Solutions, a Hyderabad-based RESCO. The project was financed through an IREDA loan under the RRD project. Sungrace was the prime mover in the initiative: it identified this region as a potential market; sourced the cooperative as a possible delivery agent for the lanterns, developed the project, attended to the loan application formalities with IREDA, organized the supply of lanterns and installed them, trained their technicians, and educated the users.

Wahandharak is promoting solar lanterns as a part of its regular savings schemes in Kolhapur. Solar lanterns are offered as an incentive for opening a recurring deposit with the bank. A small proportion of the recurring fee goes towards payment for the lantern.

The recurring deposit is designed in such a way that the solar lantern is fully paid for over 10 years. For the members of the cooperative, another method of obtaining a solar lantern is to have the fee deducted from the annual dividend that the depositor receives on the share capital. In both schemes, the cooperative collects a fee from the users and passes it on to IREDA for repayment of its loan. The cooperative has seven branches in rural areas for its banking operations, which are also used as service centers for solar lanterns. Sungrace trained some of the collection agents as solar technicians to take care of minor repairs and provided service support for the lanterns for one year.

The model clearly shows that grassroots micro-credit organizations can be used as effective vehicles for disseminating SPV systems. The risk involved in this kind of business in the PV sector is low as the device is small, compact, easy to handle, and comparatively less expensive (as compared to other PV devices, such as solar home systems). That these grassroots organizations have strong ties with the communities and an existing infrastructure that can be utilized for promoting solar devices is the strength behind the model. Since the promoter is serving the client within its existing service territory, it can create a critical demand level, which helps it to provide cost-effective maintenance and administrative support.

Community Power Plants for Remote Areas: Sagar Island

The West Bengal Renewable Energy Development Agency (WBREDA), which is the state nodal agency responsible for the promotion of RETs in West Bengal, has been instrumental in setting up nine off-grid SPV power plants in Sagardweep[16] – an island in the Sundarbans delta – three of which have been partially funded by IREDA with a 20-year soft loan at **1%**.

Sagardweep has a population of 0.15 million spread over 16 villages. The only source of power in Sagardweep is a diesel generator station run by the SEB, which supplies power to around 650 households for four hours in the evening. The villages rely on wick-lamps and hurricane lanterns except in a few villages where private operators supply electricity through diesel generators. Each of the SPV plants supplies power to 80 to 90 families in one or two adjoining villages through a local grid. The consumer base has exceeded 1,200, with many more villages waiting for connections. Beneficiaries are selected on a first-come-first-served basis and their ability to make a one-time payment or a deposit combined with a monthly payment. The tariff has been so fixed that the annual interest charges and operating and maintenance (O&M) costs can be serviced. Each consumer pays Rs 100 per month for a connected load of 100 W (there is not metering). The average consumption is limited to 80 W for five hours every day, which works out to about 12 units per month. This is cheaper than the Rs 6 payment for five hours per day for one 40 W lamp, if the connection is taken from the local diesel generator set.

The key player in this set-up is the Sagardweep Rural Energy Development Cooperative Society, Ltd, representing the consumers of electricity and local government officials. WBREDA is responsible for the overall coordination and management, while the day-to-day tasks such as payment collection and plant management are taken care of by the cooperative. The repayment performance has been very good so far, primarily because most users have realized the benefits of quality lighting, and would prefer to borrow and pay rather than face disconnection.

Sagar Island provides the proverbial "niche" market for SPV plants. This is a place where it is infeasible to extend grid electricity, the existing source of electricity is in extremely short supply and is not likely to be expanded further, and the people are willing and able to pay for the service. For this reason, all the stakeholders take an active interest in the functioning of the cooperative. As there is a demand from most non-electrified villages for SPV plants, there

[16] Sagar Island is a part of the delta of River Ganga, located at a point where the river enters the Bay of Bengal. It is characterized by mangrove swamps and islands interwoven by a network of small rivers and waterways.

is a constant pressure on the existing ones to function well and to the satisfaction of the consumers. Other reasons for success include:

- The villagers fully understand that it is practically impossible to extend the grid from the mainland to supply power on the island and that the SEB-operated diesel generator has reached its full capacity and is not likely to serve any more connections. In such a situation, the only hope is from solar energy. Further, the people who have been using power from the SPV plants have got used to the benefits of grid-quality power, for lights, fans, and televisions and have a personal interest in ensuring that the management structures function well.
- The program has the full support and involvement of the local government authorities. WBREDA has done this effectively by ensuring representation of government departments in the cooperative society.
- The simple fee collection mechanism managed by the local people has ensured regular payments.
- The local entities such as *panchayats* have realized the utility of the project and feel a stake in it.

4.4.3 Lessons from the RRD project

4.4.3.1 Public Private Partnership

Developing partnerships at the project level is crucial for success of rural energy projects. This is particularly relevant in the case of SPV where innovative institutional and financial packages are required to make the systems affordable and accessible to a wide range of consumers. Rural financing institutions are important for delivering credit rather than expecting equipment suppliers to also be credit providers. Working with local government bodies and organized consumer groups will reduce risks, as there is peer pressure to ensure repayment, and also help minimize transactions costs.

4.4.3.2 Financial Packaging

Given the high front-end costs of SPV products, they cannot be marketed across the board without appropriate financial assistance. As different institutional models emerging under RRD project demonstrated, however, it is important to design such packages to suit specific local conditions. Such packages will help expand the market, especially if such marketing work is taken up by local micro-credit agencies, cooperatives, and NGOs.

4.4.3.3 Consistent Incentive Structure

In the initial stages, given the high perceived risks, the government provided strong incentives to private developers to promote their involvement and develop a body of experience and expertise that would lead to maturing of the market. But once such objectives are achieved, it is important for the government to review the support structure and provide clear signals to the market. For instance, in the case of SPV, IREDA launched the low-interest scheme even while MNES carried on with their cash subsidy program, both often competing in the same areas, which led to confusion for the consumers as well as project developers.

4.5 Village Hydro Systems, Sri Lanka

4.5.1 Background

Sri Lanka has had a rich history of micro- and mini-hydro use since the late 1800s in its tea plantations. About 500 such units had been abandoned as the CEB grid arrived in the 1960s. ITDG used these existing civil works to demonstrate and carry out field trials with simple micro-hydro technology. It also developed a pool of people who could design, install, and maintain these units. The Sri Lankan small hydro program was initiated in 1979 by the Alternative Energy Unit of the CEB. This was followed by an NGO-led strategy based initially on the refurbishment and demonstration of micro-hydro power in the tea estates and subsequently on workshop training programs and the creation of village-based electricity supply committees.

4.5.2 The ESD Project

The ESD village hydro program, operated by the Development Finance Corporation of Ceylon, has essentially consisted of four strands:

- Rehabilitation of hydro on the tea estates.
- Village hydro scheme with a strong emphasis on community development.
- Capacity building of village hydro specialists who act as catalysts.
- Grid-connected systems.

4.5.3 Implementation Mechanisms

The off-grid village hydro schemes are applicable for villages at a distance of 5 km or more from the existing grid. Most of these schemes have the capacity of producing 5 to 15 kW and are located in remote rural areas where there is no electricity from the main grid. The ownership, management, financial control and load regulation are carried out by the local electricity consumer society (ECS). These are social organizations formed by the villagers that consume the power delivered by the village hydro plants. The administrative functions of the existing village hydro systems are minimal and limited to organization of labor for initial preparation work, provision of electricity connection to members of the society, collection of monthly payments from members, and performance of day-to-day activities of power generation and distribution. The society as an administrative unit also deals with issues such as non-payment of monthly fees and disputes that arise among members due to over consumption by some members or non-availability of electric supply to others.

The project developer is the prime mover for the village hydro schemes. He identifies a site, motivates the community, organizes them into an ECS, helps them in obtaining necessary clearances and statutory approvals such as land and water use clearances, as well as environmental clearances, approaches a PCI for a loan, supervises design and installation, and trains the operators. The initial investment required for site identification has to be made by the project developer. The consultancy fee of the developer is linked to achievement, **50%** is paid on PCI approval, and the balance at the time of first disbursement by the PCI.

4.5.4 Subsidy and Financing Mechanisms

The local banking system is typically not geared to granting the type of long-term financing with grace periods that are necessary for the development of small hydro plants because most of its liabilities are in the form of shorter-term deposits from the public. To address this issue, the project offers long-term refinance at attractive rates to commercial and development banks for on-lending to private sector small hydro developers. The project also supports project preparation costs, which are paid separately from grant funds made available under the ESD project, subject to a maximum of US$ 9000.

Subsidies for Micro-hydro in ESD project

- Capital subsidy linked to kW-output basis (US$ 400 per kW installed, up to a maximum of US$ 20,000)
- Separate grant for project preparation (subject to a maximum of US$ 9,000)
- Occasional grants available from provincial councils
- Loans given directly to the ECSs that contribute 30 to **40%** of the project cost, increasing interest and involvement of the provincial councils
- Technical assistance and capacity building support

Typically, these projects are financed from four sources:

1. Sweat equity of the villagers (**30%**, though sometimes the provincial councils give a loan to cover this component)[17].
2. Loan under the ESD (**50%**).
3. Co-financing grant of US$ 400/kWh (**20%**), up to a maximum of US$ 20,000.
4. Occasional grants from the provincial council[18] from its decentralized budget for energy.

Under the ESD village hydro schemes, the loan is given directly to the member of the ECS, two other members standing guarantee for the loan. The households pay a fixed monthly charge to the ECS, which in turn repays the loan to the bank. Each household pays SLR 300 to 500 per month for a period of four years after the grace period of three months.

A break down of the financing structure for a few projects under ESD[19] is given in Table 4-4.

[17] During the initial years, ITDG insisted that the ECS provided **30%** of the capital cost of the project and this would be provided in cash, kind, and sweat equity, and would cover civil works and transmission. Barnett 1998 reported that while the ECS were generally able to contribute their **30%** of the cost to cover the civil works, they were often unable to raise the funds from their own resources to cover the cost of the transmission. They frequently had to seek supplementary funding from the provincial councils for this, thereby adding delays to the project implementation.

[18] Some provincial councils eg, Sabaragamuwa, are already providing financial assistance to village hydro systems. The current practice is ad hoc and to a greater extent is dependent on the capability of the ECS to influence the political authorities.

[19] CAPS is one of the leading consultants in village hydro power. It has been actively involved in formulation of the ESD and implemented several pilot projects. 19 out of 38 projects undertaken under the ESD have been through CAPS. This information is based on projects implemented by CAPS.

Table 4-4 Financing Structure for Micro-hydro Projects under ESD

Project Name	kW	No. of households	PCI	Total Project Cost (SLR)	ECS Equity (SLR.)	Term Loan	GEF grant
Hettikanda – Marandola	7	23	HNB	977,000	200,000	609,000	170,000
Handunella	10	50	Sampath	1,480,000	408,000	800,000	272,000
Hakkalaella – Berannawa	10	60	HNB	1,280,000	397,000	730,000	163,000
Kawudubuluwa	12	52	HNB	1,330,000	330,000	630,000	370,000
Kithulritiela – Perupalla	6	21	DFCC	745,000	225,000	380,000	140,000
Watagala	10	46	HNB	1,400,000	350,000	760,000	290,000

4.5.5 Tariff Setting

It was accepted that people in these relatively remote areas were unlikely to be able to meet a substantial part of the cost of the schemes. Currently, for most projects, the tariff is set on the basis of the monthly expenditure on kerosene, battery recharging, and the replacement cost of batteries, and is normally comparable to the household's monthly expenditure on energy[20].

4.5.6 Achievements

Under the ESD, 2,600 households have been covered through village hydros till May 2002 (RERED 2002). The program has had considerable success in absorbing the technological know-how and improving it through local manufacture, developing local capabilities in manufacture and installation, developing the capacities of manufacturer/catalysts to guide the ECSs, and in pushing for changes in the regulations.

The provincial councils are encouraging small hydro in a big way. So far, out of the 50 odd projects that have been financed, almost **50%** received some contribution from the provincial councils. Many of the PCs, local governments, and banks have included village hydro in their work plans and programs. Over 35 small hydro projects have been initiated in the Southern Province, outside the ESD project.

[20] The average monthly expenditure on kerosene for rural households is in the range of SLR 250 to 600. A recent study (IDEAS 2001) estimated the approximate energy cost per household to be in the range of SLR 500.

Item	**Rs**
Kerosene	160.00
Dry Cells for operating radio	140.00
Wet battery charging cost	100.00
Wet battery replacement cost	113.00
Total	513.00

4.6 Village Hydro Systems, Nepal

4.6.1 Background

In Nepal[21], **85%** of the population lives in rural areas. The national electrification rate is **13%**, but above **80%** in the cities. The low electrification rate provides a large market to be served by micro-and mini-hydros and by SHS. The power forecasts prepared by Nepal Electricity Authority (NEA) foresee that **30%** of national households will be connected to the grid by the year 2020.

Nepal has had a long-standing micro-hydro program; over the years, four broad approaches have been tried:

1. Promotion, development, ownership, and management by national power company (NEA)
2. Private entrepreneurs investing in micro-hydro schemes for productive purposes and add-on electricity for the local community (subsidy in the range of **25% - 40%**)
3. ADB/N acting as an intermediary institution for channeling the government subsidy on RETs and loans to community-based micro-hydro projects that have been identified by manufacturer and donors
4. REDP, which has the specific objective to promote micro-hydro through community mobilization

Ghattas or traditional watermills have been in use for centuries, and an estimated 25,000 are still in use. Turbine-powered agricultural milling, which were able to provide good returns developed without any government subsidy. Mills were able to maintain high load factors as a result of this and did not need to look for other end-uses in areas where there was enough milling work. Milling in Nepal was supported with credit from the Agricultural Development Bank of Nepal (ADB/N) but needed no government subsidy.

In the mid-1980s, there was a shift in focus towards electricity-producing micro-hydro projects. Many donors and NGOs found micro-hydro an entry point to rural development. Electricity for evening lighting became an end use in itself – an activity that could be carried out using spare power of the turbine in the agricultural processing mills. An average household needed around 100 W for lighting. This meant there was a lot of power available that milling, which requires 20 W per household[22] or less, could not use. Applications were needed to make use of this available power. As a result, add-on electric plants became popular.

4.6.2 Subsidy Framework for Micro-hydro Projects in the 1980s

In 1985, subsidies on rural electrification were announced by the government, including a capital subsidy ranging from **50% - 75%** for electrical and transmission cost components of

[21] AEPC 1999; Barnett, A. 1998; ESAP 2000; Khennas, S. and Barnett, A. 2000; Pandey, B. 2000; Vaidya undated

[22] Some of the early mills are reported to have served as many as 500 to 1,000 households. If the power of the mill was 10 kW, then the per household power requirement comes to 10 to 20 W. The village of Barpak reportedly has two 4 kW mills serving around 600 households (Khennas et al 2000). This works out to around 13 W per household.

micro-hydros up to 100 kW. During this period, no subsidy was available for the machines used in the processing of agricultural products and mechanical equipment. For community-owned projects, the subsidy often covered **70% - 100%** of the project cost. Further, as tariffs were set at levels too low to cover the costs of O&M and debt servicing, in effect, even the operation was subsidized. Even though no direct subsidization was taking place, the effect was visible in the form of overdue and unpaid loans and plant breakdowns as no reserves were built up to pay for major repairs. For entrepreneur-owned micro-hydro projects, the state provided subsidies covered **20% - 30%** of the total project cost.

Other provisions for the micro-hydro sector, as defined by the Hydropower Development Policy of 1992 and the Electricity Act 1992, were as follows:

- No license required to operate hydroelectric project of up to 1,000 kW capacity.
- No royalty on the hydropower projects of up to 100 kW capacity.
- Financial institutions to offer concessional loans to the private sector for generation and distribution of electricity up to 1,000 kW in any rural areas.
- Exemption of income tax.
- No import license fee, sales tax on construction equipment, spare parts.
- The owners of the decentralized electric utilities not connected to the national power grid can fix their electricity tariff rates.
- In the event that the national grid systems is extended to areas having local systems, NEA shall arrange for purchasing power plants, transmission and distribution lines if the private parties so desire.

During this period, a few micro-hydro projects, especially add-on plants, were installed. This subsidy model did not function very well: a study on the functional status of micro-hydro demonstrated that **75% - 80%** of the plants had loans overdue and some **30%** were not operating, for a variety of reasons including poor site selection, inadequate/inaccurate surveys, wrong size, poor installation, faulty equipment, poor estimation of hydrology, neglect of civil work, inability of owners to replace a generator after breakdown, wrong estimation of raw materials, of demand, of end use possibilities, oversized plants, overestimation of tariff collection, inappropriate rates, ignorance of competition with diesel (Mostert 1998). This model failed to attract as many entrepreneurs as it used to before the installation of milling and add-on micro-hydro plants. The demand for milling micro-hydro completely stopped after the introduction of a subsidy on electrification schemes.

4.6.3 Existing implementation Mechanisms

The current phase of the strategy involved the creation of the Alternative Energy Promotion Center (AEPC) in 1996 as an autonomous body overseen by the Ministry of Science and Technology (MST). The Danish International Development Agency (DANIDA) is providing significant technical and financial support to the AEPC through its Energy Sector Assistance Program (ESAP). The ESAP is a long-term commitment, expected by DANIDA to last 10 to 15 years. DANIDA is assisting those elements of the program that promote micro-hydro development and SPV. The current delivery arrangement for micro-hydro projects involves the following steps:

- Pre-feasibility and feasibility study by certified companies, consultants, or NGOs.

- Appraisal of the feasibility study by the Mini-grid Support Program (MGSP).
- If found appropriate by the MGSP, the proponent applies for subsidy to the Interim Rural Energy Fund (IREF) in the prescribed format.
- IREF releases **50%** of the subsidy to the manufacturer/contractor (manufacturer gives a performance bond prior to the payment).
- The project is commissioned.
- The entrepreneur or the social organization requests the IREF to get the output of the project verified through the IREF specified person/institution.
- After verification of the output, IREF releases the subsidy amount, with **10%** retained against guarantee and after sales service.
- The retained amount is released at the end of one year from the date of verification after ascertaining equipment quality through evaluation.

Subsidies under the ESAP Program, Nepal

The procedure for obtaining a subsidy under the ESAP program in Nepal requires the villagers to make an application to AEPC, after which AEPC sends a consulting team for a pre-feasibility study (financed under ESAP). Once the project is approved in principle, a detailed survey is carried out, for which the village community is responsible and hires a consultant for preparing a DPR. For this job, the community is provided financial support (NRS 30,000 to 40,000) under the project. Finally, the village community applies for the subsidy, negotiates with the manufacturers, and arranges for financing the balance of the project cost.

4.6.4 Subsidy and Financing Mechanisms

In the present setup, bulk of the subsidy is channeled through the AEPC, and the rest by the government. In 2000, a new government subsidy policy led to a marked increase in subsidy levels, from **20% - 25%** of the total investment to **50% - 75%** of the total investment. The new policy links subsidy to a kW-output basis, a strategy expected to make manufacturers pay attention to quality aspects. It also places micro-hydro in a rural development perspectives by making **10%** load from productive uses mandatory.

Financing Mechanisms Operating in Nepal Micro-hydro Program

- Capital subsidy linked to kW-output basis
  - NRS 55,000 per kW for projects up to 3 kW capacity (mainly peltric)
  - NRS 70,000 per kW for projects above 3 kW
- Investment ceiling of NRS 150,000 per kW
- **10%** load from productive end uses mandatory
- Additional transportation subsidies for remote locations
- NRS 35,000 per kW or **50%** of costs for rehabilitation projects
- NRS 27,000 for add-on electricity generation from improved ghattas (watermills)
- Household tariffs on the basis of installed capacity or on the number and type of electricity-using equipment that the household uses, no household metering
- Grant for DPR preparation (NRS 30,000 to 40,000) routed through the village community

4.6.5 Tariff Setting

In most micro-hydro projects, household tariffs are based not on metered consumption, but on installed capacity or on the number and type of electricity-using equipment the household uses. Household metering equipment is not installed in micro-hydro projects. Households pay according to the number of light bulbs they use or according to their demand for capacity – a fuse/cut-off device will typically limit the maximum demand of a household to 100 W. Monthly household charges are NRS 0.5 to 2 per W capacity, or NRS 50 to 200 per month. The cost of internal wiring is around NRS 2,000 and the connection charge over NRS 2,500.

4.7 Argentina Rural Electrification Program

Concurrent with the deregulation of its energy markets over the past decade, Argentina initiated a program to supply electricity to un-electrified rural areas of the nation. The program, the Electric Supply Program for the Rural Dispersed Population, aims to provide electricity to 1,400,000 rural users (about 300,000 households) and 6,000 public services, such as schools and hospitals. The electrification takes place in two distinct areas, grid expansion and distributed generation.

In grid expansion, the government, operating with a variety of capital supplied by domestic and international sources, fully subsidizes the installation of the grid connection, but allows the operating company to charge the user the full cost of power as well as for future maintenance requirements. Internal wiring and connections are supplied by the user.

The bulk of the on-going electrification in Argentina utilizes dispersed generation technologies, such as renewable energy technologies like solar, wind, or hydropower. In some cases, diesel generation sets are also used. In this system, private businesses must bid for concessions in different regions. The government grants a concession to electrify a given region based on the business offering the least-cost plan. The concessionaires must provide service to all who ask for it within an exclusive area and fully subsidize the initial cost of installing generation equipment. This subsidy is provided from the future fees charged to rural consumers, funds from the provincial level, and national funds, much of the latter being provide by foreign or multinational organizations. Users must contribute at least **10%** of the costs, with the share depending on capacity to pay in the province and on the size of the system.

Connection subsidies are paid to the operator on proof of installation and decline over time. Users are responsible for the installation and maintenance of equipment installed in the home or building, such as wiring. They are charged a set installation and connection fee of US$ 74, as well as a monthly fee designed to finance their portion of the installation and future maintenance of generation equipment, which remains the property of the concessionaires. It is estimated that average monthly costs to users are within the same range as present spending on kerosene, candles, or other forms of traditional energy.

Subsidies Operating in Argentina Rural Electrification Program

- Electricity supply for rural dispersed population
- Sources of supply: solar, wind, hydro (mini/micro)
- Connection/capital subsidy equivalent to **90%** of cost, granted to operator
- Subsidy is financed by domestic and international sources
- Users meet the cost of internal wiring, maintenance, and electricity consumption

The program was viewed as a success in its initial phases. Over time, however, it encountered some problems as users often failed to differentiate between the generation equipment and internal wiring, thus not fully maintaining their private capital. Problems also arose when users did not follow the concessionaires' guidelines and attempted to use many appliances at once on the limited capacity.

The key strengths of the Argentine rural electrification program are

- Creation of a market of sufficient "critical mass" for commercially sustainable business by granting exclusive rights over a large geographic area
- Attracting larger, better organized private companies with their own sources of financing
- Easier administration and regulation
- Good potential for reducing unit costs of equipment (through volume discounts), transactions, operation and maintenance (through economies of scale) and per unit overhead costs
- Ensuring service to the consumer over a long period (ie, 15-year contract life of the concession)

4.8 Chile Rural Electrification Program

Rural electrification in Chile has traditionally been the domain of state-owned power companies, which followed centrally developed plans and relied on subsidies from the central government and on cross-subsidies from tariffs set above costs for urban consumers. During mid-1990s, more than half the rural population of Chile had no access to electricity. To increase rural access to electricity, Chile launched a new rural electrification program in 1994, aimed at reaching **75%** of the rural population by 2000 and **100%** by 2004.

Chile uses a rural electrification fund with a planned life of 10 years to offer one-time, competitively awarded subsidies to local operators bidding to provide service. The Chilean scheme uses competition for grants but does not offer an exclusive concession. Local operators, working with community groups, commit to a target for new connections. To apply for a subsidy, companies submit their projects to the local community, which then submits them to the regional government. The regional government allocates funds to those projects scoring best on several objective criteria, including cost-benefit analysis, the operator's investment commitment, and social impact. Only projects with a positive social and negative private return are considered for subsidy. The size of the subsidy depends on the number of beneficiaries, the unit cost, and the financing needs.

To help ensure buy-in, all participants, including the government, private sector, and users, are required to contribute funding for the program.

Users must cover the cost of the in-house wiring, the electric meter, and the connection to the grid. These expenditures, which average to about **10%** of the total cost of each project, initially are financed by the distribution company and repaid by users over time through their monthly bills. The distribution company is required to invest an amount established by the government, using a formula established for the purpose. Operators receive the subsidy up front and must make a minimum contribution to project costs according to a formula set by the government. The company must also operate, manage and maintain the project, recovering its costs through tariffs.

The government provides a subsidy for the investment costs that is no more than the negative net present value of the project, which must be less than the total investment. Grants from international organizations also have been used for projects, especially those involving experimental technologies involving self-generation and other alternative energy sources.

The program was instrumental in increasing the coverage of electricity in rural areas from **53%** in 1992 to **76%** at the end of 1999, exceeding the target rate of **75%** by 2000. The initiative has demonstrated that it is possible to create market incentives that lead to cost-effective solutions to rural electrification involving the private sector.

Subsidies in Chile Rural Electrification Program
- Up front subsidy to consumers from operators
- Consumers pay back capital costs in installments with the electricity bills
- Subsidy is partly funded by the Government
- Grants from international organizations used

An innovative aspect of the program is its reliance on competition among users; central, regional, and local governments; and private sector participants to reduce costs and improve the efficiency of specific projects. Private companies have helped define projects, made investments, undertaken the commercial risk, and own and operate the projects. The demand-driven approach to choosing projects helps to ensure that those selected have local support and that there is sufficient willingness to pay for electricity. It also improves the probability that the forecast demand for new connections and electricity will materialize rapidly, thus helping to ensure projects' financial viability, and that the allocation of capital costs and subsidies is targeted toward maximizing the desired output – the delivery of electricity services.

4.9 Thailand Rural Electrification Program

Thailand initiated its highly successful rural electrification program in 1974, which is centrally run by a public electricity distribution company, the Provincial Electric Company (PEA), set up specifically to provide electricity in rural areas. It operates separately from the traditional utility, which is responsible for electricity supply in Bangkok and other urban areas. Selection of areas for electrification is based on a set of criteria including proximity to the grid, accessibility by road, village size, number of expected customers in first five years, potential agricultural and industrial loads, number of commercial establishments, and extent of public facilities. Those villages that meet these criteria are given higher priority for electrification than others. Villages that are able to raise funds themselves, however, to contribute to the cost of electrification can be given higher priority. It is common for wealthy villagers, or village political leaders, to raise the needed funds privately for this purpose.

Subsidies in Thailand Rural Electrification Program
- Cross-subsidy from urban to rural and large to small consumers
- Lifeline tariff is set at 35 kWh/month

While the cost of village extension is primarily born by the national government and the PEA, villages are encouraged to participate in the process. Communities meet to discuss electrification before the process begins. The community as a whole has to agree on right-of-way usage during construction, and local leaders are trained to collect bills and report maintenance problems.

The Thai program includes a cross-subsidy from urban to rural customers and from large to small consumers. Lifeline rates for the first 35 kWh of service are applied for poor people who used small amounts of electricity, primarily for lighting. Because of such limited use by the poor, the lifeline rates did not adversely affect the financial performance of the utility.

In Thailand, the number of electrified villages has increased from **20%** in 1974 to a current **98%**. Its success can be attributed to a set of factors including careful expansion planning, efficient billing, a cross-subsidizing rate structure designed to charge large users higher amounts than small users, responsiveness to customers, and good marketing programs Additionally, the program created a process by which villagers were closely involved in the electrification program.

4.10 The Philippines Rural Electrification Program

The grid electrification program of the Philippines started in the 1970s and initially met with great success. Rural electric cooperatives (RECs) were established to act as distribution companies in rural areas. Regions needing electrification were studied for economic viability of grid expansion. In regions deemed acceptable for electrification, the National Electricity Authority (NEA) would build the initial distribution grid, thus subsidizing initial capital cost. Upon completion, grid ownership would be transferred to the REC, which would assume a portion of the original construction cost, in the form of outstanding loans from the NEA. The REC would than be responsible for running, maintaining, and expanding the local system. The final tariffs collected by the REC were to cover operational costs and repayment of NEA loans. The electricity would be purchased from the national grid.

Subsidies in Philippines Rural Electrification Program

- Initial capital subsidy from NEA to RECs to build distribution grid to rural areas
- REC's tariff to consumers includes the operational costs and consumed electricity costs

But the NEA soon abandoned its strict criteria for establishing RECs. By 1980 120 RECs had been created, many of them in financially unviable regions. Tariff collection levels became extremely poor and many RECs suffered from lack of adequate funding and maintenance. The situation has yet to be resolved.

4.11 Dissemination of Solar Home Systems in the Dominican Republic and Honduras

The Dominican Republic has a rural population of 3.2 million, of which **35%** is connected to the grid. Since 1994, Soluz Dominicana, a subsidiary of the US firm Soluz, has been implementing a successful fee-for-service business in the Dominican Republic for electricity service from SHSs.

Under the fee-for-service scheme, customers pay a start-up fee and a fixed monthly fee of US$ 10 to 20 per month to rent SPV system packages for lighting, radio, television and communications, along with many income-generating activities. Soluz installs the 50 Wp systems and provides all maintenance under a contract. Any changes that are made to the system are made by Soluz technicians, which keeps the systems from being broken or overloaded. In addition to homes, Soluz's customers include a range of micro-enterprises, including many small country stores using the energy for lighting, radio, and television, thus helping them to attract customers during longer working hours. Collection rates have been typically over **95%**.

Financing Mechanism in Solar Home Systems in the Dominican Republic and Honduras

- Source is SHS
- Consumers pay start-up cost and a fixed monthly charge ($10 to 20 per month)

Soluz's operations in the Dominican Republic received financial support from a range of NGOs, foundations, and development institutions including the Rockefeller Foundation, E&Co, a venture finance company, as well as support under the IFC Small and Medium Scale Enterprise program. By April 2000, Soluz Dominicana had served more than 3,500 customers, including about 1,700 systems on a fee-for-service basis. Soluz is also replicating the fee-for-service concept in Central America by establishing Soluz Honduras.

One of the main reasons for the success is that Soluz does not subsidize the cost of providing energy service to the rural household. Even customs and value-added taxes are accounted for in the cost-structure and Soluz has made no efforts to obtain tax exemptions from the Dominican government. At the operational level, Soluz has a large incentive to maintain the systems because Soluz owns the systems: it is in the company's best interest to maintain the systems well so that the batteries have a long life and the users remain satisfied. Consumers are not obligated to pay if their system is not functioning, so maintenance calls are responded to quickly and efficiently. System owners are well educated about the limits and requirements of their solar systems because owner knowledge is one of the best ways to maintain system integrity. Soluz has the incentive to educate owners, because it is the company who will have to purchase new parts if the owner abuses the system.

Section 5 Subsidy Design Principles for Grid-connected Rural Electricity Supply

5.1 Introduction

Grid extension is the most commonly utilized approach for extending energy to rural communities. Rural electric cooperatives present a viable public sector approach by serving as distributors of grid electricity to rural communities. Many governments provide subsidies to rural electric cooperatives, in the form of low-interest loans with long repayment periods and subsidized power purchase rates, as incentives to develop a business to serve rural populations. This section suggests guidelines for designing subsidies and financial mechanisms for grid-connected electricity supply. The recommendations are based largely on the experience of the rural electric cooperative models of Bangladesh (the REB-PBS model, Section 4.1) and India (rural electric cooperatives, Section 4.2).

5.2 Issues in Designing Subsidies and Financing Mechanisms for Grid-Connected Rural Electricity Supply

Rural electric cooperatives face several challenges in their operations that have direct implications for designing subsidies and financial mechanisms for them. The key issues are discussed in this section.

5.2.1 Electricity Market for Rural Electric Cooperatives

The market for rural electrification essentially consists of (1) households dispersed in villages and village hamlets, (2) shops clustered in rural markets, (3) small and often informal industries (rice mills, agro-processing units), and (4) tube wells for irrigation. Many of the RECs operate in difficult and remote areas with poor load mix and low level of economic development. Given this, the profitability of operations can vary considerably between RECs. It is evident that the extent of financial and other support received by the RECs should reflect this degree of difficulty. Some of the factors that influence this are as follows:

- **Load Mix:** Most rural electric cooperatives operate in areas that are underdeveloped with little or no industry and have a heavy bias towards the domestic sector[23]. Subsistence-level energy consumption activities such as lighting account for the bulk of the power consumed. Further, loads are highly dispersed and isolated, which increases the cost of operations. In addition, an overwhelming proportion of domestic consumers fall in the minimum bill category[24]. So even when the density of the population is high, the actual revenue generated per km of line is small
- **Remoteness and Accessibility:** The REB experience shows that while some cooperatives have a good customer mix, those in the more remote areas are struggling to produce positive margins, even after years of operation. This difference is because grid extension is more expensive in remote areas and such areas typically have low consumer density

[23] In the REB-PBS setup, domestic consumers account for **84.16%** of the total connections, the commercial sector for **11.36%**, irrigation for **2.4%**, and industrial uses for **1.8%** . In addition, a significant portion of domestic consumers pay the minimum bill each month. Less than **20%** domestic consumers pay more than Tk 200 per month (Prokaushali Sangsad 2000).

[24] In the REB-PBS setup, **84%** of the customers fall in the lowest bill category (Tk 70 per month) consuming less than 20 kWh of energy per month (REB personal communication).

Taking over Loss-making Service Areas: Usually, the RECs take over service areas and systems (substations/distribution lines) from existing state utilities that are inefficient and incurring high losses. This necessitates high investments, both for system improvement as well as for expansion, which the RECs can ill-afford without external financial support

Take over from Other Utilities

Since the REB started operating, the other utility, BPDB, has retained networks within municipal boundaries and certain "exempt" institutions (eg, universities), while handing over the remaining parts of the network to REB/PBSs. The application of the "municipal boundary" rule leaves many small geographic areas of low load with BPDB and forces uneconomic supply to such areas from the BPDB network. When the PBSs inherit the relatively inefficient systems of BPDB, it takes them some time before they can overcome the inefficiencies. The REB has now established a more rational policy, whereby all pocket areas, including municipalities up to 3 MW loads, are to be transferred to the PBSs (World Bank 2002) on an economic basis, allowing entire lines and associated facilities in a pocket area to be transferred in one package as opposed to in fragmented handovers.

5.2.2 Economic Development Potential and Load Growth Pattern

The program philosophy behind the ACRE distribution strategy is that electricity distribution infrastructure is developed in a way that it loses money in the early years before load growth catches up to begin to cover the cost of the service. REB data, however, suggests that the load mix for most rural electric cooperatives does not change significantly with time[25]. This indicates that provision of electricity by itself may not provide enough stimulus for rural industry growth.

Economic Development Indicators

- Quality of infrastructure, particularly of roads
- Trends in crop types and agricultural productivity
- Productive uses in farms and agro-industries
- Accessibility to markets
- Government plans for development of the area

Consequently, provision of electricity does not necessarily promote a level of economic development that can create electricity demand high enough to generate revenues to offset losses made by the PBS during the initial years. This calls for a careful assessment of potential economic development in the area, based on indicators including infrastructure, agricultural productivity, productive uses in farms and agro-industries, accessibility to markets, and number and range of income generation opportunities that would benefit from the infusion of energy into the area.

5.2.3 Cross-subsidization

The practice of cross-subsidization between industrial and commercial sector and the households assumes that over time, as rural economies develop, financial sustainability can

[25] Analysis of load mix data for 67 PBSs shows that in terms of number of connections in each category, the relative shares of domestic consumers as well as industry are almost the same for old PBSs as well as those established recently. The share of domestic consumers, which is **83.8%** for PBSs less than five years old, is more or less the same for more than 20-year-old PBSs at **83.77%**. In terms of power consumed, the share of industry is smaller (**29.8%**) in the case of older PBSs than those established less than five years (**54.5%**).

be achieved by marketing power to industrial and commercial clients. In practice, however, cross-subsidies from industrial to residential elements have not been successful. The Bangladesh experience shows that

1. The cross-subsidization results in sales of electricity below the present cost of service to the large domestic sector and revenues from consumption in the higher rate categories are insufficient to offset losses incurred due to low rates in the domestic and agricultural categories
2. The load growth in the industrial sectors (which are charged higher tariffs that are expected to offset the losses made in the domestic and agricultural sectors) in new PBSs has been sluggish

In Bangladesh, the average tariff per kWh falls short of the cost of providing service. In the late 1990s, the average cost of providing service across all PBSs was Tk 3.30 or US$ 0.066 per kWh (NRECA 2000). Weighting the tariffs for each category by the respective share of power consumed, the NRECA calculated the average revenue at Tk 3.05 per kWh, implying an overall loss of Tk 0.25 per kWh across the REB system.

5.2.4 Equity Issues

Electricity is known to make a positive impact on the lives of people, improving both quality of life and economic returns. The Unnayan Shamannay study carried out in rural Bangladesh reported that income in electrified households was about **50%** higher than in non-electrified households (Zomers and Bosch 2000). This analysis, however, does not necessarily establish a causal relationship. Poverty may have been reduced as a result of the advent of electricity, but it is equally likely that electricity has been introduced in the richer areas. Although electrification appeared to improve the average living standard in developed PBSs (over five years old), the differences between the poorest and richest households grew in the electrified villages.

Once electricity becomes available in an area, upper middle class and wealthy households are the first to adopt it. Experience suggests that electricity by itself cannot generate economic development and hence the expectation that poorer households will wire up at a later stage may be misplaced[26]. In fact, rural electrification can even increase inequities between rich and poor in rural areas (Cecelski 2002). Those who can afford to invest in electrical appliances that support income-generating activities benefit the most, while others are left out. The cost of securing a residential connection itself may present a substantial barrier for those living at a near-subsistence level. Hence, special provisions may be required to ensure that poorer households are able to access the services.

Currently, people who are not connected within PBS areas include those who can afford to pay for electricity, but are located at some distance from the grid lines or live in small clusters (not enough numbers to justify grid extension to the cluster), and those who are poor and live near the grid line, but cannot afford to pay for power. It may be mentioned that the likelihood

[26] Analysis of load mix data for 67 PBSs shows that in terms of number of connections in each category, the relative shares of domestic consumers as well as industry are almost the same for old PBSs as well as those established recently. The share of domestic consumers, which is **83.8%** for PBSs less than five years old, is more or less the same for more than 20-year-old PBSs at **83.77%**. In terms of power consumed, the share of industry is smaller (**29.8%**) in the case of older PBSs than those established less than five years (**54.5%**).

of others being connected to the grid over time is diminished by two facts: (1) the households who are not connected the first time are generally the poorer ones, and hence would find it difficult to afford electricity even later, and (2) for the PBS, it becomes increasingly more difficult to connect additional, poorer, households while meeting the revenue requirement.

5.2.5 Financial Performance of Existing Rural Electric Cooperatives

Profitability of the cooperatives emerges as the single most important issue in this model. There is a concern that the financial performance of many of the PBSs has not progressed as was originally planned. The REB policy expects a PBS to be financially self sufficient after five years of energizing. In reality however, many PBSs continue to encounter budgetary shortfalls, even after more than 10 years of operation. Of the 67 PBS, only 23 had a positive margin in 1990-00 (Zomers and Bosch 2000). Of the PBSs that were in the operation for longer than five years, only 16 showed a positive margin. One explanation for this phenomenon is that the electrification started with the more promising areas and the areas being covered now are more difficult, hence it is more difficult to achieve sustainable levels of operation in them.

The lackluster financial performance of most PBSs can largely be attributed to the typical load mix for a PBS, which is heavily biased towards the domestic sector. Unfortunately, growth in the industrial and commercial load has not been enough to balance the losses arising from the low domestic and agricultural rates. Another reason behind the sluggish performance is the continuing desire to extend service to as many un-electrified villages as possible, many of which have little industrial and commercial demand for electric service (NRECA 2000).

Foley (1995) suggests that for rural electrification programs in general, the weaker the financial state of a utility, the more important it is to focus its rural electrification efforts on areas where a reasonable financial rate of return can be obtained. If, in the early stages, resources are expended on electrifying areas where an adequate rate of return cannot possibly be achieved, the utility becomes progressively weakened financially, managerially, and operationally, and the overall progress of rural electrification is jeopardized.

5.2.5.1 Factors Influencing Sustainability

Traditionally, rural electric cooperatives are expected to require a subsidy in the initial years, and then to operate profitably with economic development brought about by electrification. In reality, whether and when a REC will become financially sustainable is influenced a by a range of parameters, including the

- Type and level of demand in the service area
- Distribution and density of customers
- Access to the larger grid
- Type of generation or supply available to the cooperative

5.3 Suggested Guidelines for Subsidies/Financing Mechanisms

5.3.1 General Principles

The basic objective of providing financial support for centralized grid-connected rural electricity supply is to provide incentives to develop a business to serve rural populations, largely by removing the constraints and distortions existing in traditional rural energy markets that make electricity supply business unprofitable. The proposed strategy is

- To provide capital grants during start-up
- To provide concessional interest rates and longer (non-commercial) grace periods
- To phase out subsidies for mature rural electric cooperatives

5.3.2 Subsidy Delivery Mechanisms

5.3.2.1 Variable Level of Financing

The nature and extent of financial support need not be uniform across rural electric cooperatives. The overall financial position of the cooperative should be an important consideration for determining the level of financial support. In fact, the level and duration of support should directly be linked to the degree of difficulty that the cooperative is likely to face in attaining financial sustainability.

5.3.2.2 Cross-subsidization

There should not be any cross-subsidization across RECs. The financial resources of the healthy RECs should not be called upon to cross-subsidize those RECs with historically poor results to the extent that is now occurring. If the cross-subsidization remains large, the probability remains unacceptably high that financially weak RECs abandon the drive for efficiency and increased load and rely instead on continued subsidies from the financially strong RECs. There is a need for each PBS to operate as an independent utility, ensuring its own sustainability by managing costs and realizing adequate revenues.

5.3.2.3 Support from State Utilities

The RECs should be viewed as an integral part of state electricity boards, while maintaining autonomy in functioning. In Bangladesh, this is already so. In general, it appears unjustifiable to treat a REC as a separate, profit-making utility, when (1) it is operating in an economically underdeveloped area, (2) does not have the freedom to fix consumer tariffs, and (3) has to operate in the same environment as subsidized programs like Kutir Jyoti.

5.3.3 Subsidy Mechanisms for Rural Electric Cooperatives

5.3.3.1 Financial Support during Start-up

It is proposed that the RECs do not get direct cash support, but built and transferred line assets that meet connection criteria.

5.3.3.2 Rationalize Power Purchase Rates

The state utility must ensure a reasonable degree of stability in power purchase rates. The bulk rate for RECs should be fixed by deducting costs of the RECs. The costs the SEB would incur if it were to operate in the same area and serve the same clients can be taken as a proxy for estimating the operating costs of the RECs[27].

5.3.3.3 Support for Efficiency Enhancement Measures

To ensure high quality projects, the government should make investments that would improve the quality of projects and help the RECs attain high levels of efficiency. Some areas for investments include

- Providing technical assistance in developing projects, feasibility studies, and energy demand forecasting
- Developing sound operating systems and management practices
- Training local staff

5.3.4 Subsidy Mechanisms for Final Consumers of Electricity

Subsidies for final consumers should enhance access for the poor (improving the quality of life and reducing energy expense); sustain incentives for efficient delivery and consumption; and must be practicable within the existing resource constraints of the government and the REC. The following financing mechanisms are suggested for the final consumers of electricity:

5.3.4.1 Reducing Access Costs

The initial connection charges demanded by the utility (and the internal wiring costs) are often a far greater barrier to rural families than the monthly electricity bill – a household that faces problems in paying for its monthly bills has the option of cutting down the monthly consumption. Unless financing is available, the poor may choose not to electrify[28]. Some options that can be explored to reduce the burden of access costs include

- Offering micro-credit for financing the cost of connections
- Reducing these charges, or spreading them over a several years, even if it means charging more per unit of electricity[29]
- Treating part of the internal wiring costs as part of the connection investment and adding it to the monthly extra charge during the payment period

[27] In India, the bulk power rates are fixed by the state electricity regulatory commissions (SERCs). In West Bengal, the RECs are treated at par with any other bulk consumer of power and charged the same rate, which is quite high. At the current level of consumer tariffs, this bulk purchase rate makes the operations quite unviable for the RECs.
[28] In Nepal, for instance, the cost of connection in NEA projects is NRS 2,800 on average and the cost of internal wiring NRS 2,000 as a minimum (NEA personal communication). The combined upfront costs are often more than **10%** of average annual rural household income. The typical connection charge in Sri Lanka is in the range of SLR 5,000 to 7,000 (including SLR 100/m from the closest LT line and the internal wiring, which costs around SLR 5,000).
[29] In Nepal, micro-hydro schemes like Ghandruk were able to achieve **100%** connection rates by having modest connection charges. The consumers pay for internal wiring.

Access Costs in Bolivia

In rural Bolivia, the primary constraint faced by the poor was the high connection costs. The electricity company offered to finance the connection charges, allowing customers to pay back the costs in small monthly installments over a five-year period. In return, they receive electricity service during evening hours. As a result of this financing scheme, the number of households who were able to purchase electricity doubled.

Source: World Bank 1995

5.3.5 Tariff Policy

In rural areas, the electricity rates that the rural electric cooperatives can charge are dictated by two objectives, which are often in conflict. On one hand, there is a desire to keep power rates within reach of the purported customer, that is, the tariff should not be higher than the prevailing tariff in the adjoining areas. On the other hand, for its own sustainability, the cooperative needs to maintain rates at a high enough level to recover the cooperative's annual expenses incurred in the purchase, transmission, and distribution of power.

Most RECs operate in small pockets surrounded by typical state utility-served areas fraught with problems of power thefts, un-metered connections, and low efficiencies. In such a situation, even if the REC is able to offer quality service, the consumer willingness to pay for the service, influenced by the surrounding area, is quite low.

In terms of consumers' expectations regarding price of electricity, it is important to keep the tariff level at par with the prevailing tariffs in the region. A tariff lower than the surrounding areas would mean losses, while at the same time, a higher tariff seems unjustifiable to the consumers, unless the utility provides some value-added services.

5.3.5.1 Lifeline Tariffs for Poor Customers

In areas where income levels are very low, it may be necessary to subsidize consumption as well as connection costs. Lifeline rates at low levels of consumption (below 25 kWh) would encourage poor households to adopt electricity (World Bank 1995). Such a service level would be enough to power two light bulbs and a radio or black-and-white television set. It is, however, important to note that lifeline tariffs have little impact unless the barrier of high initial upfront cost of internal wiring and connection charges is addressed simultaneously.

5.3.6 Exit Strategy

There is a need to set clear, time-bound financial goals for financial support for grid-connected electricity supply.

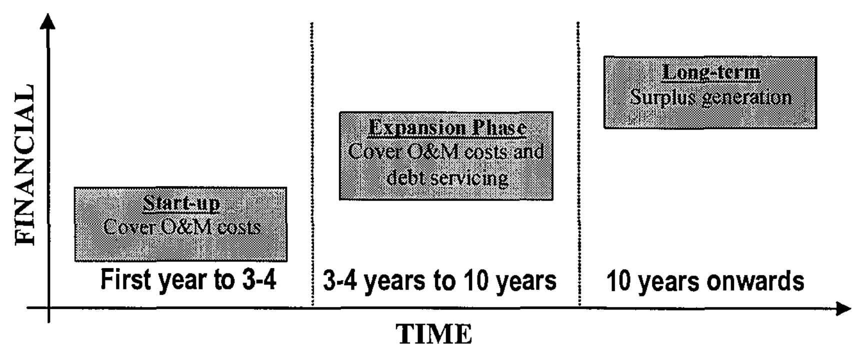


Figure 5-1 Financial Goals for Grid-connected Rural Electricity Supply

According to guidelines suggested by the World Bank (Foley 1995), the financial goals of programs should be

1. To comfortably cover operating and maintenance costs during the first three or four years
2. From this point to the tenth year, they should be able to service the debt of the program
3. Thereafter they should show a surplus that would enable them to make an increasing contribution to the costs of expansion

All RECs must generate sufficient program income to cover operating costs, including reserves to finance system improvements.

Section 6 Subsidy Design Principles for Off-grid Decentralized Energy Systems

6.1 Introduction

Rural electrification programs have typically concentrated on connecting villages and remote areas to a national grid – often owned and operated by a public utility. Extending an electricity grid to a remote village can be very expensive, especially if only a few households are to be connected. Because of the problems of supplying grid electricity for small, scattered, peaky loads, decentralized electricity generation is increasingly becoming more attractive. In many remote locations, even a mini-grid may not be feasible, for reasons including inhospitable terrain (which makes it difficult as well as prohibitively expensive to draw distribution lines) and wide disparities in the economic status of users (which makes it difficult to establish a coherent payment and benefit-sharing system). The only alternative is to have individual systems, with technological options of battery-based systems, kerosene or diesel generators, or SPV systems. A brief summary of the subsidy mechanisms for decentralized solar home systems, as existing in the study countries, is presented here in Table 6-1.

Table 6-1 Subsidies and Financial Incentives for Solar Home Systems

Country	Subsidies and Financial Mechanisms
India (MNES program)	▪ Rs 6000, or **50%** of ex-works cost, whichever is less, service charge of Rs 200 ▪ Fiscal incentives including concessional customs duty, excise duty exemption and **100%** depreciation in the first year
India (IREDA financial package)[30]	▪ Loan financing for up to **85%** of the project cost, at **2.5%** rate of interest to be repaid in 10 years, with a moratorium of 1 year, minimum promoter's contribution **15%**
Nepal	▪ Rs 8000 for SHS of 30 or above watt peak, to be reduced by **10%** every year[31]. ▪ **50%** of the total cost or Rs 8000, whichever is less, for SHS below 30 Wp ▪ **75%** of the total cost for public places such as schools, public buildings, PV powered irrigation and drinking water
Sri Lanka RERED project	Subsidy basis and amount as follows, limited to one sub-grant per household and per system: ▪ Year 1: 10 to <20 Wp (US$ 40); 20 to < 40 Wp (US$ 70), 40 to 60 Wp (US$ 70) ▪ Years 2 and 3: 10 to < 20 Wp (US$ 40), 20 to 40 Wp (US$ 70) Years 4 and 5: 10 to 20 Wp (US$ 40)

Requirements for Promoting Sustainable Decentralized Energy Options

- Field-proven commercial equipment

[30] Provision under the RRD project, which came to a close in December 2001. Currently the provision includes loan financing for up to **70%** of the project cost, at **14%** rate of interest to be repaid in eight years, with a moratorium of two years, minimum promoter's contribution **30%**.

[31] Currently, the subsidy is NRS 7,200.

- Local competitive commercial infrastructure for supply, installation, operation, and service
- Policies that support market development in rural areas
- Financing mechanisms for developers, suppliers, intermediaries, and end users

6.2 Issues in Designing Subsidies and Financial Mechanisms for Decentralized Energy Systems

6.2.1 Meeting First Costs of Decentralized Energy

For consumers, appropriate financing may be required to cover "first costs" related to purchase of an individual energy system. Many consumers who would otherwise be able to afford to purchase modern fuels often cannot afford the high first costs of appliances and services. In fact, it can be said that consumers' ability to pay for energy services is determined to a large extent by the financing to which they have access. In general, the potential customers of decentralized energy services can be divided into three broad categories, based on income levels (see Figure 6-1).

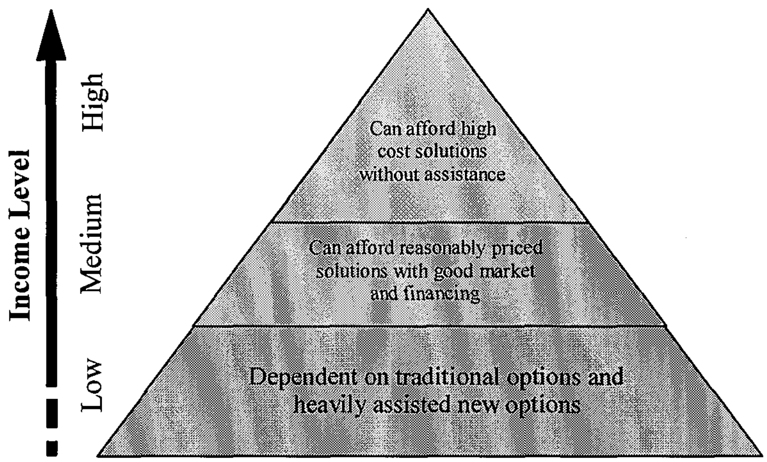


Figure 6-1 Income Levels and Affordability of Energy Services

Even with financing options to meet upfront costs, the monthly fee commitment can be an obstacle, especially when compared to the completely discretionary small payments typically made for fuels like kerosene. For the middle-income group, the purchase price of options like SHSs is a barrier: for many families it represents up to **50%** of their annual income (Barnes and Jechoutek 1998). The initial purchase price can be a significant obstacle for higher income groups as well, even though with higher disposable incomes and expectations, they may be accustomed to frequent cash outflows on battery charging[32]. For the upper-income

[32] Grameen Shakti's experience indicates that even with financing options, rural households having monthly income over Tk 4,000 or US$ 71 are the prime customers of their SHSs (Sohel 2002). Grameen Shakti offers a range of payment systems to its customers. Option 1: customer pays **15%** of the total price of the system as down payment and the rest (**85%**) is paid with **12%** service charge (interest) within three years in 36 monthly installments. Option 2: customer pays **25%** of the total price of the system as down payment and the balance (**75%**) is paid with **8%** service charge (interest) within two years in 24 monthly installments. Option 3: customer pays **15%** of the total price as down payment and the balance (**85%**) including **10%** service charges

family already using a car battery, the 100-Wp SHS would provide a more comprehensive electricity service of considerably higher quality, and at a lower cost than they are now paying[33].

Cost Comparison: The Dominican Republic

In the Dominican Republic, a US$ 700 solar home system can be purchased for a **25%** down payment and 24 monthly payments of US$ 30. In contrast, combined household expenditures on kerosene, dry cells, and automobile batteries for lighting and power can reach US$ 35 per month. Moreover, the householder's monthly outlay for the solar home system will end after two years, with the exception of battery replacement.

Source: Cabraal et al 1998

6.2.2 Choice of Service Delivery Mechanisms

The design and implementation of subsidy instruments is closely intertwined with the service delivery mechanisms available in a particular country. The delivery model strongly determines the degree to which potential service providers are able and willing to enter the market, put their capital at stake, and respond to local demand. The delivery mechanism also strongly influences the on-going costs of operation and the choice of subsidy instrument itself. In recent years, there has been considerable experimentation with alternative service delivery models. In this section, we discuss some of the key service delivery models in use. Table 6-2 summarizes the key features of each of these delivery models.

Table 6-2 Characteristics of Energy Service Delivery Models

Characteristic	Dealership	Leasing	Concession	Fee for Service)
Affordability	Low	Moderate	High	High
Interest rate	High	Medium	Low to medium	Low
Repayment period	Short	Medium	Long	Long
Down payment	High	Moderate	Connection fee	Low
Collateral/security	System/other collateral	System	None	None
Administrative cost	Moderate	Moderate	Moderate	High
System ownership	User	User (at the end of lease)	Service provider	Service provider
Level of customer service	Medium to high during loan	High during lease	Provided	High
Sustainability	Low to moderate (requires continued financing)	Moderate (requires continued financing, needs local presence)	Moderate to high	Moderate to high (RESCO has local presence)

Source: Adapted from Newton and Rovero 1999

are to be repaid by 36 account payee checks in advance and cash purchases, for which Grameen Shakti provides 4% discounts on total price of the system.

[33] In Bangladesh, the estimated baseline demand for SHSs is 12,000 to 15,000 households gaining access in the next five years. But surveys reveal that such households are more likely to be in the relatively higher-income bracket, earning incomes around US$ 1,000 per annum (World Bank 2002).

6.2.2.1 Dealership Model

The dealership model emphasizes the development of dealers that can sell equipment, usually photovoltaic, to people living in rural areas distant from the grid. This model builds on existing retailer networks in developing countries that service rural areas. The rationale for providing some form of subsidy to such dealers is to lower the cost of the product and thereby increase consumer demand. In a variant of this model, dealers arrange for consumer financing with a bank, and by lending to dealers the bank transfers the collateral problem from the end user to the dealer. The dealer in turn lends to purchasers using payment schemes compatible with their income. Dealers must bear the financial risk along with technical risks.

6.2.2.2 Leasing Model

The leasing model involves bulk procurement of equipment by a leasing company (lessor) and marketing either through a direct lease or a lease-to-own agreement with the end users (lessees). The lessor retains ownership of the system or gradually transfers units to the end user. When the lease agreement expires, most programs give the lessee the option to purchase the system. Leasing is a convenient arrangement for the end user as the demand on liquidity is low. Leases often have longer terms than most loans, so the periodic repayment is lower. In addition, there is usually minimal or no down payment, except for a security deposit. This approach, however, needs higher initial capital costs since the lessor must be able to procure initial systems in bulk. Achieving financial stability is more challenging because of the longer term of leases and lower periodic repayment. The case of Wahandharak in India is discussed in Section 4.4.

6.2.2.3 Concession Model

The concession model for the development of off-grid electrification was developed as a way to minimize budgetary subsidies and encourage private sector participation. The model depends on regulation by contract more than market forces, but it helps ensure that economies of scale are achieved. The process involves the government identifying priority areas for off-grid electrification, followed by bidding for area concessions by interested players, and the government awarding concessions for a specified period, similar to a franchise.

6.2.2.4 Fee for Service Model

In the fee-for-service or energy-service company model, the firm provides fee-for-service to specific territories but without monopoly status granted by a regulator. A service provider (possibly a RESCO) makes available a system to an end user. The end user never takes ownership of the system but signs a contract with the RESCO for installation, maintenance, and repairs, and agrees to make periodic payments in return for the energy services obtained. Consumers are expected to provide some form of security, possibly a down payment, with failure to meet monthly payment obligations for energy services leading to termination of service.

6.2.3 Credit Availability and Choice of Financing Option

The type of financial institutions and their respective activities will impact how effective an option financing will be. Ideally, local financial institutions, already operating in the target areas, with a good knowledge of potential borrowers and a level of comfort with the degree of risk, should participate in financing for energy services as well. Table 6-3 presents a summary of traditional sources of finance in rural areas. Financing for energy services may be dovetailed with one or more of these.

Table 6-3 Local Rural Sources of Finance

Source	Borrower	Features
Family or friends	Consumer	Common, restricted by lender's limited resources
Moneylender	Consumer	Common, credit can be expensive
Supplier credit	Dealer	Rare and unlikely for a new product
Informal institutions (local)	Consumer	Common, limited capacity
NGOs	Consumer	Targeted programs, small loan amounts
Local banks	Established businesses or loan-worthy clients	High transaction costs restricts loans to large amounts

Source: ESMAP 2001

Some of the key issues in credit availability for decentralized energy in general and SPV in particular are as follows.

Parameters for Assessing Local Credit Availability

- Current banking activities in the area
- Lending practices in the target area
- Cost of consumer borrowing
- Transaction costs for servicing loans
- Loan repayment performance

6.2.3.1 Credit Availability through Conventional Banking

Credit availability for renewables through conventional rural channels is a constraint in most developing countries. Most large banks usually do not have the local knowledge or facilities to be involved in micro-credit and the smaller banks or rural cooperatives prefer to lend for income generating activities like agricultural or cottage industries. Lending to individuals for the purpose of making a down payment on a PV system is perceived as high risk (IEA 2003, Hande and Duffy 2001). Furthermore, the credit structures tend to be rigid and loans made only to those with sufficient collateral or good credit history. In situations where market-based consumer financing is available for SPVs, interest rates on SHS loans tend to be high on account of the large transaction costs relative to the size of the loan. Where commercial financing or leasing schemes are available, a down payment of **25% - 30%** may be required.

6.2.3.2 Inability of Service Providers to Deliver Credit

Credit risk is a serious concern of both financiers and dealers (Miller and Martinot). In most scenarios, private PV companies (dealers) are in a business that has yet to reach large-scale commercialization. They carry considerable overhead and operate with slim margins and hence are not geared to take on the rural credit aspect as well[34].

6.2.3.3 Choice of Financing Option

The choice of financing option should be based on the needs of the consumers given the constraints of the local credit markets. For consumer lending, there are essentially two options: (1) cooperative financing, and (2) consumer credit.

Cooperative financing – ie, group lending to a village organization – may be more appropriate than individual credit given the possibly of low credit worthiness of the target consumers. Consumer credit is relatively rare in rural areas. Consumer credit may be provided directly by dealers or through local banking networks, including micro-finance institutions. Service providers can also provide credit by including connection and service fees on consumers' bills, allowing them to spread costs over many years. Other approaches for financing include use of revolving funds (with grant support) and concessional funding for public sector objectives, in which the government contracts and pays a local company to provide energy services that meet development objectives, such as photovoltaic lighting for schools. This approach provides entry capital for the company to offer credit and expand its business to other local markets.

6.2.4 Suitability of Candidate Service Providers

There must be sufficient technical capacity within the target country or region to design, install, and service systems on a sustainable basis. This step involves an assessment of the ability and willingness of the potential energy service delivery agencies to (1) establish a distribution network, (2) provide some degree of financial commitment or investment, and (3) provide installation and technical service support.

Some of the key issues faced by service providers in decentralized energy provision are presented below.

6.2.4.1 High Transaction Costs

The transaction costs of running decentralized energy businesses in rural areas are quite high, because of the following factors:

- Need for remote maintenance and repair infrastructures to ensure satisfactory service
- Servicing set-up unsustainable before a critical mass of customers is reached
- Rural sales, marketing, and installation processes are time-consuming and resource-intensive
- End-user financing done on a piecemeal basis can be difficult for financial intermediaries

[34] This lesson is illustrated in Sri Lanka, where manufacturers like Solar Power and Light Company and Alpha Thermal experimented with providing consumer credit, but gave up soon, citing the high costs of credit collections in remote rural areas.

6.2.4.2 Working Capital Problems

Most decentralized energy systems, especially SPV systems, account for a high cost of inventory. A good amount of working capital is required by any entrepreneur to sustain a comfortable level of business. According to SELCO India, to hire a technician for a year will cost the entrepreneur Rs 15,000 approximately, which is equivalent to the cost of a four-light home lighting system. The primary bottlenecks faced by the entrepreneur in obtaining working capital include a lack of confidence among banks regarding renewables, hesitancy to extend working capital loans, and absence of soft loans for start-up businesses in renewables.

6.2.4.3 High Costs of Market Development

For any new technology or product, the market development, or "trail-blazing", costs are very high. Once the market is developed, and some systems are in place and functioning well, there is a demonstration effect and the local market is likely to pick up and competitors move in. It is clear that the company investing in a promotional campaign cannot reap the benefits of its market development efforts alone and quickly.

SELCO Lanka's Market Development Costs (SLR)

Year	Number of Systems	Average Annual Cost (000)	Average Cost per System
1998	50	1,810	36,200
1999	644	23,350	36,257
2000	2,194	77,400	35,278
2001	10,906	374,070	34,299
2002	11,447	387,020	33,809

Source: SELCO personal communication

6.2.4.4 Lack of Capital to Create Innovative Financing Mechanisms

Consumer items such as refrigerators and color televisions are being sold easily in the rural markets because of the attractive financing schemes offered by consumer product dealers. These financial mechanisms have been formulated after feeling the pulse of the local economy and the needs of the local people. Absence of financing to experiment with innovative approaches has created a handicap for SPV business in general and entrepreneurs in particular.

6.3 Suggested Guidelines for Subsidies/Financial Mechanisms

6.3.1 General Principles

The Energy Sector Management Program (ESMAP 1999) suggests the following broad principles for applying subsidies appropriately for decentralized energy services:

- Support for access but not consumption
- Creation of a market without distorting market rules
- Equitable use without creating or reinforcing a monopoly
- Neutrality in terms of technological choices
- Support for the installation of high-quality systems

- Support restricted to programs that would not be viable without the subsidy

For the region, it is proposed that the subsidy strategy should:

- Pre-announce subsidies will be given only for a pre-defined period
- Pre-announce declining subsidy rates during the period
- Promote maximum number of different system sizes on the market

6.3.2 Subsidy Delivery Mechanisms

6.3.2.1 Use Multiple Credit Channels

As it is difficult for commercial banking systems to reach isolated consumers, a number of supplementary approaches will have to be utilized. Local institutions or NGOs can play a major role in providing energy services; especially decentralized ones, and effort should be made to identify competent and experienced organizations in energy, community development, or rural finance. Some of the approaches that can be tested include

- Involving NGOs to mediate commercial bank credits and assist in functions like identification of beneficiaries, conducting credit checks, and mediating for loans
- Promoting alternative financing mechanisms, such as credit lines, loan guarantees, and hire-purchase and leasing schemes that expand the energy market[35]. Governments should support innovative financing mechanisms that allow lenders to offer long-term credit on reasonable terms
- Use group loans/group guarantee schemes to reduce the costs of transactions

It is important, however, to assess accurately the capacity of local institutions, so that their core competencies can be harnessed to the program and the capacity building needs can be identified. An established track record and history of success in the target area are good indicators of capacity. If such an institution does not exist, one may need to be created through the support of the project, if the proposed activities are large enough to support such an organization.

6.3.2.2 Ensure Consistency in State Policy

Consistent policies regarding subsidies are needed. The main problem with conflicting policies is that they send confusing signals to the manufacturers as well as final consumers. Especially in the early market development stage, when a technology or product is a new and risky proposition for the manufacturers, conflicting policies can slow down the market development process considerably.

Two experiences in this regard are instructive. In Uva province of Sri Lanka, the provincial council's announcement to provide an additional subsidy of Rs 10,000 per SHS met with a mixed response. While new customers were happy about the move, many of the old customers (especially those who had purchased SHS recently) refused to pay the installments (SEEDS, personal communication). Some even asked SEEDS to mediate and obtain

[35] The World Bank supported programs in Sri Lanka and Bangladesh selected this as a primary strategy, making long-term loans available for energy activities. While the Sri Lankan ESD project has been quite successful, it is still premature to examine the efficacy of this strategy in Bangladesh.

subsidies for them too. Conflicting policies were also observed in Nepal, where the subsidy scheme provided for **50%** of the capital cost, not exceeding NRS 15,000 on solar home systems of capacity around 30 Wp living in specific designated districts[36]. However, as the amount allocated for this purpose in the national budget was inadequate, the scheme ran out of funds within three months, causing widespread complaints.

6.3.3 Subsidy Mechanisms for Service Providers/Manufacturers

6.3.3.1 Provide Start-up and Working Capital Loans

In the initial stages of market development, providing financial support to manufacturers to develop the market and for working capital has proved to be a useful strategy. During the market development phase, capital subsidies on investment are useful, especially when the commercial interest rates are as high as **20% - 22%**, making investments in a new sector risky. The IREDA loans in India were instrumental in bringing in new manufacturers and service providers in the SPV market.

6.3.3.2 Co-finance Market Development and Promotion Costs

Subsidizing initial awareness and trail-blazing costs helps to ensure that the business returns would be proportional to the investments made by the market pioneers[37]. It is suggested that co-financing be provided for specific and targeted promotional campaigns targeted at specific geographic units or specific stakeholder groups, such as banks and NGOs.

SELCO and Market Development Costs

SELCO, in both India and Sri Lanka, was one of the pioneers of SHS in the region, as a result of which their market development costs were very high. For its India operations, apart from some external support, SELCO was able to absorb the initial market development costs by retaining the cost reduction realized through economies of scale as the market grew and ploughing these sums back into the business. In fact, this is the reason why the final consumer prices have not come down significantly over the years despite increasing demand and reducing input prices.

6.3.4 Financial Mechanisms for Local Institutions

6.3.4.1 Facilitate Involvement of Local MFIs

Experience shows that dealers are willing and able to manage the risks associated with the marketing and technical aspects of energy technology delivery and service. They have neither the necessary infrastructure nor the expertise, however, to assume the risks of being suppliers of credit as well. Hence, there is a need to segregate these two functions by encouraging MFIs or other specialized groups who can handle credit management. MFIs are closer to rural customers than commercial banks, their transaction costs are lower, and they are more capable of dealing with financing aspects than dealers.

In the ESD and RERED projects in Sri Lanka, the MFI designs the consumer loan package for end users, screens applicants, executes loan agreements, and pays dealers/developers for

[36] Under the new subsidy policy, the subsidy on SHSs has been fixed at NRS 8,000 for SHS of 30 or above Wp, to be reduced by **10%** every year and for SHS below 30 Wp, at **50%** of the total cost or NRS 8,000, whichever is less.

[37] The World Bank projects in Sri Lanka and Bangladesh absorbed some of these costs by investing in the generic promotion of SPV technology in the country.

SHSs installed for households. But MFIs are not typically equipped to deal with financing for energy as they typically deal with smaller loan sizes (US$ 50 to US$ 500), lend for income generating activities, for short periods (four months to one year), and charge an interest rate slightly higher than the commercial rate (but lower than local alternatives like moneylenders). Engaging them for financing decentralized energy involves

- Providing refinancing facilities to enable them to provide medium-term loans
- Providing them with capacity-building support for better credit management and other technical expertise

6.3.5 Subsidy Mechanisms for Final Purchases

6.3.5.1 Flat Subsidies Linked to Product Size

The subsidy can be given either as a percentage of the purchase cost of the system, or in the form of pre-announced declining flat rates (a flat US$ per Wp of the system). It is suggested that product subsidies be made available

- On a declining basis
- Linked to product size, where smaller systems get slightly higher subsidies per Wp

The subsidy design for SHSs under the RERED in Sri Lanka can be used as a basis for this[38].

6.3.5.2 Encourage Consumer Choices

Customers desire a range of component options and service levels and can benefit from even small systems. Subsidies should offer choice to the consumers in terms of system sizes and configurations. The ESD project in Sri Lanka specified a minimum system size of 50 Wp, but the RERED allows smaller system sizes. Most sales in Sri Lanka have been of 32 Wp systems (selling for about US$ 450). In China, systems as small as 10 Wp are allowed as long as components meet the required standards.

6.3.5.3 Offer Financing Options

In rural areas consumers may need financing to overcome first cost and affordability issues. Monthly installments need to be structured so that they are not very much above the present expenses borne by the householder on kerosene or any other fuel the household might be using currently.

6.3.6 Exit Strategy

An important goal of subsidies for any new technology is pump priming, ie, getting the market mobilized beyond the first hurdle of small market demand. Market development follows the typical S-curve path, with small initial sales followed by an increase in demand and finally leveling off. The expansion comes as prices fall due to economies of scale and as consumers become aware of the product through exposure to systems that have been installed by others. Once the initial awareness creation stage is over, the second stage of market

[38] In Argentina, the ESCO concessions are given a variable grant amount (a one-time payment for each system installed), which declines for installations made in later years of the project and also depends upon system size. The grants decline gradually to zero by the end of the five-year project.

development requires an incentive for the consumer to invest in the technology, thereby expanding demand and allowing manufacturers to reap economies of scale. It is, however, important to

- Pre-announce that subsidies will be given only for a fixed period
- To have pre-announced declining subsidy rates during the period

The objective of pre-announced declining subsidy rates is to accelerate consumer purchases in the initial years while they can still get the high subsidy rate (for consumers who would otherwise have postponed their purchase). A general roadmap for subsidies for off-grid decentralized energy service is given in Figure 6-2.

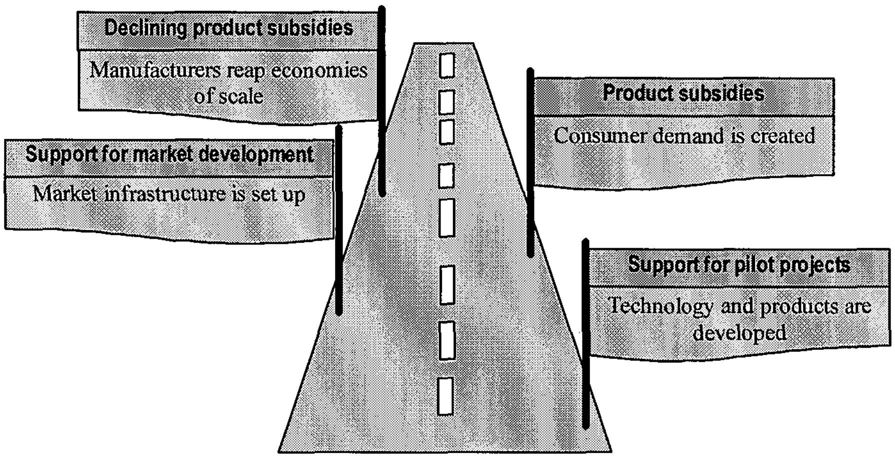


Figure 6-2 Roadmap for Subsidies for Off-grid Decentralized Energy Options

A right time to phase out financial mechanisms is difficult to define. The complete phasing out of financial mechanisms including subsidies would be when the market and the technology are both fully developed and able to stand on their own. This would also require that the major players in the industry have developed capabilities to compete in the free market. Market-driven financial mechanisms (non-subsidized) would then fill the gap created by the declining subsidies. A useful indicator of this stage is when banks and other financial institutions start approaching the industry on their own accord.

Section 7 Subsidy Design Principles for Centralized Off-grid Energy Systems

7.1 Introduction

Decentralized, isolated distribution systems are common in remote areas that have significant population centers, such as villages and small towns. In most developing countries, including India, diesel engines have been used to generate electricity for isolated grids. In Nepal and Sri Lanka, development of relatively inexpensive mini- and micro-hydro systems has been successful in serving remote areas. Electricity can also be generated from fuels such as biogas or biomass, depending on availability of local resources. It should be noted however that the development of micro-grids, whatever their primary source of energy, requires a significant level of community consensus and support on factors such as billing, service, and organization. Local participation is a key ingredient in the design implementation and day-to-day operation of such isolated systems. In fact, the participation of the local community can help considerably to reduce costs, enhance consumer satisfaction, and provide a financially viable investment.

7.2 Issues in Designing Subsidies and Financial Mechanisms for Centralized Off-Grid Energy Systems

7.2.1 Costs and Benefits of Micro-hydro Systems

The average cost of a village hydro scheme in Nepal is in the range of NRS 100,000 per kW[39]. However, a major advantage of micro-hydro is that it can be built locally at considerably less cost than it can be imported, and the costs of local manufacture can be reduced by developing local engineering capabilities and advisory services. In the case of centralized micro-grids, the market boundary is largely defined by the vicinity of the centralized power plant, as only those households who are located within a few km from the plant can access the power generated from it. Two factors that influence the economic viability of such initiatives, and hence must be ascertained beforehand, are remoteness and the prospects for micro-hydro end-use and enterprise development.

7.2.1.1 Remoteness

Micro-hydro projects (MHP) are located in rural areas at considerable distance from electric transmission lines and distribution networks. Remoteness is an important factor as the cost of the MHP is site specific and varies greatly depending on the remoteness of the site and physical features of its major components, namely civil works (including waterways), generating equipment (eg, turbine, generator, control, protection), and distribution lines. While the cost of generating equipment is almost a linear function of the kW size, the cost of civil works and electrical lines depend on geographical factors; therefore, the unit cost of MHP installations can vary widely from scheme to scheme. The share of initial civil works component cost may vary from **20% - 60%** (Vaidya undated). In Nepal, some **25%** of total costs for a micro-hydro project can be for transportation of equipment and materials alone, but are much lower in less mountainous regions.

[39] For MHPs constructed with support from REDP, unit costs range of Rs 87,000 (US$ 1,279) to Rs 121,000 (US$ 1,779) per kW (Vaidya undated).

7.2.1.2 Potential for End-use Development

Not all areas are equal in terms of their suitability and prospects for end uses. Only those few areas with road access, high agricultural production, tourism attractions, or proximity to district headquarters are suitable for a wide variety of end uses (Pandey 2000). Subsistence-based economies, with little market for local consumption or few if any products to sell to the outside market, have few prospects for enterprises and thus can not make full use of micro-hydropower to power them.

7.2.2 Intermediation Requirements in Centralized Off-grid Systems

Even though micro-hydro hardware is relatively simple, the intermediation requirements are substantial during all phases of project identification, preparation, investment, and operation for micro-hydro projects. Identifying and preparing rural energy service projects, such as village hydro, can be expensive, especially at the beginning of the learning curve. Under these circumstances the capacity of the developer is limited. The risks are also high as many projects are abandoned before reaching financial closure for a variety of reasons. Key determinants of the intermediation costs are as follows:

- Current level of capabilities of service providers, including manufacturers, installers, and project developers determines the need for training and capacity-building efforts, and hence investments

  Community cohesiveness and capability determines the social intermediation needs
- Local sources of finance determine the level of financial intermediation and the need for external donor finance

Intermediation Needs in the Sagar Island SPV Power Plant Project

Sagar Island is a large island with an area of around 300 sq km spread over 43 villages in the delta of river Ganges in the Bay of Bengal. When WBREDA, the state renewable energy development agency, formulated a scheme to set up eight 25 kWp SPV power plants in 1993, its involvement was total. It motivated and organized the communities, negotiated and arranged for a loan, liaised with the state government departments, entered into maintenance contracts with the technology suppliers, and provided overall technical supervision. At the local level, a cooperative looks after the day-to-day tasks such as money collection, under supervision from WBREDA. At present, many such power plants with aggregate capacity of 300 kWp are operational in Sagar Island serving around 2,000 families.

Barnett 1998 identifies intermediation functions in four categories that are essential for micro-hydro projects (see Table 7-1).

Table 7-1 Intermediation Requirements in Village Hydro Schemes

Type of intermediation	Functions
Organizational intermediation	▪ Initiation and implementation of the program::Lobbying and advocacy
Social intermediation	▪ Identification of owners and beneficiaries ▪ Development of the capacities necessary to take on and run projects
Technical intermediation	▪ Undertaking the necessary R&D, import of technology and know-how

Type of intermediation	Functions
	▪ Development of the capacities to carry out tasks like site selection, system design and technology acquisition, construction and installation of civil, electro-mechanical and electrical components, operation, maintenance and trouble shooting
Financial intermediation	▪ Administering loans ▪ Assessment of financial viability of schemes ▪ Assessment of financial credibility of borrowers Management of guarantees, collateral and loan repayment

It is clear that in the present situation, private financial institutions will not be able to cover the cost associated with many of the transactions necessary to install these systems (Khennas and Barnett 2000). Indeed many financial institutions will probably have considerable difficulty even in covering the relatively high transaction costs of "retailing" their capital resources to the people who want power from micro-hydro plant.

Financial Intermediation Costs in the ESD Project

When the ESD project was launched in Sri Lanka, the supervision and certification of loans became a major cost element. Many of these tasks were originally carried out for free by ITDG (Intermediate Technology Development Group), an international NGO. With ESD, local consulting engineers had to be hired at higher costs or the activities did not take place at all. As a result, the initial draw-down of loan funds was very low until additional funds were made available for this purpose through a GEF grant. After this point, it was possible to undertake the tasks associated with loan monitoring, and other financial intermediation activities.

Source: Khennas and Barnett 2000

7.3 Suggested Guidelines for Subsidies/Financial Mechanisms

7.3.1 General Principles

The subsidy goal for centralized off-grid systems should be to reinforce commercial orientation by reducing initial investment, increasing load by increasing the number of consumers, and encouraging economic applications of power. It is clear that community-based energy projects will need capital subsidies for some time to come. For the region, it is proposed that the subsidy strategy should

Target support to regions that are most likely to benefit from electricity

Focus on reducing the cost of the initial investment, increasing the numbers of people who have access to electricity

Avoid applying un-ending subsidies to operating costs, or more specifically do not directly subsidize the price charged to the energy end user

7.3.2 Subsidy Delivery Mechanisms

7.3.2.1 Categorization of Projects for Financial Support

From a policy perspective, community-based energy projects can be divided into three categories, based on economic characteristics of the target market and expected level of financial sustainability (Khennas and Barnett 2000). This approach forms the basis of recent changes in the Peruvian government's policies for rural electrification. The three classes are as follows:

- **Class I: Profitable Projects:** These projects are intended to make a profit, and any entrepreneur who identifies a profitable energy project is given the opportunity and the necessary guarantees to implement it. This category would have micro-hydro projects in areas where productive end uses are likely to be most feasible. Productive end uses are likely to have a much stronger impact on poverty reduction through employment generation than lighting applications of MHP projects
- **Class II: Not Profitable but Sustainable Projects:** If these projects are adequately managed, they are capable of covering their operating and maintenance costs, even if they do not make a profit. Such projects may be given partial financial support, and the communities can be expected to generate the balance from other sources, including their own resources. These can be built with state financial support, and then transferred to the community for their operational phase. This category will include projects directed for lighting application and promoting end uses around it. These projects will never be as profitable as class I projects, but they are nonetheless necessary to expand access in relatively backward and remote areas
- **Class III: Not Profitable and Not Sustainable Projects:** These are projects in extremely remote and economically underdeveloped areas, which cannot be expected to generate even enough resources to meet operational expenses. These are justified on grounds of social equity. Such projects will need higher level of financial support

7.3.2.2 Realistic Assessment of Comparative Costs

It is essential to carry out realistic economic and technical evaluations and to compare costs of proposed projects with conventional alternatives. This has frequently not been done, and the lack has led to installation of systems that are uncompetitive with their conventional alternatives. Comparative costing must be made mandatory in DPR preparation.

7.3.2.3 Financial Support for Discrete Components

It is a useful strategy to break up the project cycle into discrete activities, such as pre-installation work (pre-feasibility, community organization), manufacturing (supply of turbines), and installation, and institute separate financing mechanisms for each of these. This is a good mechanism for risk minimization as the appropriateness of the design can be verified by independent experts, who have not been involved in the project feasibility. A manufacturer should ideally produce equipment from specifications given by others – he cannot be expected to be technically capable of performing total project assessment, nor can he be expected to be totally unbiased in his selection of turbine size[40].

7.3.2.4 Role of the Village Community

There should be a specific role for village-level community institutions, which should be made financially accountable by routing a part of the subsidy through them.

7.3.3 Subsidy Mechanisms for Off-grid Projects

7.3.3.1 Output-linked Subsidies

Three kinds of subsidies can be planned for village-based hydro projects:

1. A percentage of the total cost of investment (including cost of civil construction, of electrical and mechanical equipment, and of the turbines)
2. A flat rate per kW installed capacity
3. A flat rate per household in the first year

It is recommended that the flat rate linked to output, per kW, be applied for micro-hydro systems as it provides a stronger incentive for low-cost projects than a percentage rate, the advantages being that it is easier to administer, eliminates the incentives for artificially inflating the cost of investment[41], and encourages searching for cost reduction options.

7.3.3.2 Ceiling on Financial Support

There should be a ceiling on the subsidy amount that is provided, either in the form of maximum amount per installed kW capacity or as a maximum per household that will be connected. The latter option is most appropriate and can be fixed on the basis of an analysis of the cost structures of recently implemented projects.

7.3.3.3 Subsidies for Building Support Services

In addition to direct subsidies for investments and feasibility studies, indirect subsidies are also required to meet some of the costs of intermediation discussed earlier. These include subsidies for supporting the build-up of professional advisory and training services (Mostert 1998). The direct and indirect subsidies are mutually interdependent as, unless there is a sufficient level of investment in micro-hydro (need for subsidy), there is no economic justification for setting up elaborate supporting services.

---

[40] Earlier, it was normal practice in Nepal that micro-turbine manufacturers perform the survey and project assessment in which the turbine and generator capacities are decided (Mostert 1998). The manufacturer received a nominal fee for his survey but recovered the actual costs in the turbine price. In the present system, AEPC has divided the village hydro implementation work into three distinct components: (1) pre-installation work, including pre-feasibility and community organization, (2) manufacturing (supply of turbines), and (3) installation. This is a distinct improvement over the earlier arrangement wherein the manufacturer was taking care of most of the activities in the project cycle. It is felt that the manufactures should only concentrate on manufacturing while consultants should look after other components. Hence, the manufacturer can be the installer, but not the consultant.

[41] In Nepal when the capital subsidy was linked to the cost of electrical components, it was common for manufacturers to resort to the practice of over-sizing systems, in order to get higher subsidies.

7.3.3.4 Minimum Level of Self-finance

In many projects, financial support from more than one source reduces the contribution of the project holder[42]. While obtaining financial support from multiple sources is not harmful in itself, it does lead to a dilution in commitment level and consequently the sense of ownership within the community. This may also lead to delays as promoters wait for additional subsidies before initiating a project. The government's subsidy support programs should insist on minimum levels of self-finance (including non-subsidized loan finance) of at least **50%**.

7.3.4 Tariff Policy

The tariffs in isolated grids should be allowed to vary[43]. The revenue from the tariffs must be sufficient to cover the costs of operation, including the accumulation of reserve funds for major replacement or rehabilitation expenditure. If the population is unwilling to pay for such tariffs, the project should not be implemented.

Factors Affecting Consumer Tariffs

- Demand for services
- Type of ownership[1]
- Price of substitutes
- Subsidy policy of the government
- Tariff in nearby schemes and other surrounding areas
- Income from additional sources

[1] Private entrepreneurs have profit motive, therefore they include profit in the tariff. Tariff in private schemes generally tends to be high. Community projects, on the other hand, are normally guided by a service motive and the tariffs are low.

Source: ESAP 2000

Guidelines should be provided, however, for tariff-setting for two reasons: to ensure the financial viability of community-owned projects (adequate allocations for major repairs and for loan repayments) and to reduce tensions in tariff negotiations between entrepreneur-owners and customers.

The practice of household tariffs based on installed capacity and the number of electricity-using devices is appropriate, as the level of consumption of the households is too small to

[42] In the Sri Lanka RERED project, the ECSs typically contribute **30% - 40%** of the project cost. In some provinces, however, the provincial councils, eg, Sabaragamuwa, have started providing financial assistance to VHSs. While the interest of the Provincial Councils is reflective of their commitment and a welcome move, the current practice is ad hoc and to a greater extent, dependent on the capability of the ECS to influence the political authorities. Similarly, communities in Nepal are known draw on other sources of grants to increase subsidy levels to **50% - 80%** of the cost of investment, thereby reducing their own commitment (Mostert 1998).

[43] The present typical tariff in a micro-hydro project is around NRS 1 per month per W (AEPC 1999).

justify the cost of metering, and basing household tariffs on peak capacity instead of consumption reflects the cost structure of micro-hydro.

In spite of large-scale expansions in energy service provision, more than two billion people around the world lack access to modern energy services. Experience suggests that the private sector on its own initiative will not serve rural markets. Thus, well-designed subsidies for expanding access to rural energy services are needed. Traditionally, subsidies have been used extensively to promote wider use of modern energy carriers. Unfortunately, these have not always achieved the intended results. The welfare objective embodied in subsidies is often not realized because of their diversion to unintended uses. Typically, there is a disproportionate exploitation of the subsidies by the more affluent, who could afford to pay unsubsidized prices.

The findings of this review indicates that the success of subsidies and financial mechanisms for rural energy depends on the degree to which they are able to perform several key tasks, including encouraging strategic alliances, reducing transaction costs, encouraging efficiencies of scale, and minimizing market distortions:

- **Forming Strategic Alliances:** The challenge of meeting remote rural needs with non-traditional energy technologies in an economically sustainable way requires diverse skills and organizations. Forming strategic alliances is a means by which organizations with complementary capabilities can combine their strengths to meet the challenge
- **Reducing Transaction Costs:** One of the key barriers to affordability is the impact transaction costs have on energy system prices. Transaction costs include costs of transportation, installation, and financing, which are considerably high in rural areas. They raise the price of renewable energy technologies at all stages of the delivery chain and act as barriers to market growth. Reducing transaction costs lowers the price of the energy system to the end user, thus expanding the market and increasing the impact of the program
- **Achieving Efficiencies of Scale:** Achieving the scale required to reduce significantly transaction costs is not easy. Indeed, the success of rural energy programs depends on the transaction between villager and rural supplier, which happens on a necessarily very small scale. Often, the organizations that excel at this relationship are themselves small, local, and have limited budgets. In other cases, "bundling" loans may be an effective way of providing capital to several programs in one step. Subsidies should help service providers and manufacturer reach levels of operation where they can afford to offer lower prices to consumers, while ensuring minimum profit levels
- **Removing Market Distortions:** While the ability to pay for energy service relates the cost of energy service to the income of the customer, willingness to pay depends on the perceived affordability of the item compared to other available options. Market distortions can make least-cost energy options appear to be less affordable than other options. For example, some renewable energy technologies rely on imported components, but protective import tariffs designed to encourage local manufacture or protect local industries may drive prices up. Subsidies should help remove such distortions and provide a level playing field for all energy options

In conclusion, energy subsidies for rural people should have two main goals: to assist the poor in gaining access to higher-quality energy services and to provide business incentives to serve rural and poor consumers who would not otherwise be served, without significantly distorting energy markets. Experience shows that subsidy programs should be well-targeted, efficient, cost effective, transparent, and time-bound. For the three categories of rural energy service provision, the recommended subsidy principles are summarized as follows.

8.1 Subsidies and Financial Mechanisms for Grid-Connected Rural Electricity Supply

8.1.1 General Principles

- To provide capital grants during start-up
- To provide concessional interest rates and longer (non-commercial) grace periods
- To phase out subsidies for mature rural electric cooperatives

8.1.2 Subsidy Delivery Mechanisms

- **Variable Level of Financing:** The nature and extent of financial support need not be uniform across RECs. The level and duration of support should be linked directly to the degree of difficulty that the cooperative is likely to face in attaining financial sustainability
- **Cross-subsidization:** There should not be any cross-subsidization across RECs and each REC should operate as an independent utility, ensuring its own sustainability by managing costs and realizing adequate revenues
- **Support from the State Utility:** The RECs should be viewed as an integral part of the state electricity board, while maintaining autonomy in functioning

8.1.3 Subsidy Mechanisms for Rural Electric Cooperatives

- **Financial Support during Start-up:** In the form of built and transferred line assets that meet connection criteria
- **Stability in Power Purchase Rates:** The state utility must ensure a reasonable degree of stability in power purchase rates
- **Support for Efficiency Enhancement Measures:** Such as technical assistance in developing projects, feasibility studies, and energy demand forecasting, developing sound operating systems and management practices, and training local staff

8.1.4 Subsidy Mechanisms for Final Consumers of Electricity

- **Financing Access Costs:** The costs of residential connection may present a substantial barrier for those living at a near-subsistence level. Some options that can be explored to reduce the burden of access costs include:
  - Offering micro-credit for financing the cost of connections.
  - Reducing these charges, or spreading them over a several years, even if it means charging more per unit of electricity.
  - Treating part of the internal wiring costs as part of the connection investment and adding it to the monthly extra charge during the payment period.
- **Lifeline Tariffs for Poor Consumers:** In areas where the income levels are very low, it may be necessary to subsidize consumption as well. A monthly lifeline rate of 25 kWh or less would encourage poor households to adopt electricity.

8.1.5 Exit Strategy

Set clear, time-bound financial goals for financial support for grid-connected rural electricity supply. The rural electric cooperatives must at least cover operating and management costs in the first three to four years, cover operating and management costs and debt servicing until year 10, and thereafter generate surpluses.

8.2 Subsidies and Financial Mechanisms for Off-Grid Decentralized Energy Systems

8.2.1 General Principles

- Pre-announce that subsidies will be given only for a pre-defined period.
- Pre-announce declining subsidy rates during the period.
- Promote maximum number of different system sizes on the market.

8.2.2 Subsidy Delivery Mechanisms

- **Use Multiple Credit Channels:** Involving NGOs to mediate commercial bank credits and assist in functions like identification of beneficiaries, conducting credit checks, mediating for loans, and promoting alternative financing mechanisms, such as credit lines, loan guarantees, and hire-purchase and leasing schemes, using group loans/ group guarantee schemes to reduce the costs of transactions.

8.2.3 Subsidies and Financial Mechanisms for Service Providers/Manufacturers

- **Provide Start-up and Working Capital Loans:** In the initial stages of market development, providing financial support to producers to develop the market and for working capital is a useful strategy.
- **Co-finance Market Development and Promotion Costs:** Subsidizing initial trail-blazing costs helps to ensure that the business returns are proportional to the investments made by the market pioneers. Co-financing should be provided for specific promotional campaigns targeted either geographically or at specific stakeholder groups, such as banks.
- **Declining Subsidies over a Pre-defined Time Horizon:** It is important to pre-announce that subsidies will be given only for a fixed period, and to have pre-announced declining subsidy rates during the period.

8.2.4 Subsidies and Financial Mechanisms for Local Institutions

- **Facilitate Involvement of Local MFIs:** By providing refinancing facilities to enable them to provide medium-term loans, and providing them with capacity-building support for better credit management and other technical expertise.

8.2.5 Subsidies and Financial Mechanisms for Final Purchases

- **Provide Flat Product Subsidies:** On a declining basis and linked to product size, where smaller systems get slightly higher subsidies per Wp.
- **Offer Consumer Choice:** Offer choice to the consumers by making subsidies available for a range of system sizes and configurations.
- **Offer Financing Options:** For meeting first costs.

8.3 SUBSIDIES AND FINANCIAL MECHANISMS FOR CENTRALIZED OFF-GRID ENERGY SYSTEMS

8.3.1 General Principles

- Target support to regions that are most likely to benefit from electricity.
- Focus on reducing the cost of the initial investment, increasing the number of people who have access to electricity.
- Avoid applying un-ending subsidies to operating costs, or more specifically do not directly subsidize the prices charged to the energy end user.

8.3.2 Subsidy Delivery Mechanisms

- **Categorization of Projects for Financial Support:** It is useful to distinguish community-based energy projects into three categories, based on economic characteristics of the target market and expected level of financial sustainability:
  - Projects that are intended to make a profit, and any entrepreneur who identifies a profitable energy project is given the opportunity and the necessary guarantees to implement it (micro-hydro projects based on productive end uses would fall in this category).
  - Projects that are non-profitable but, if managed well, are capable of covering their operating and maintenance costs. Such projects may be given partial financial support, and the communities can be expected to generate the balance from other sources, including their own resources. This category will include projects directed for lighting application and promoting end-uses around it.
  - Projects that are in extremely remote and economically underdeveloped areas, and cannot be expected to generate even enough resources to meet operational expenses.
- **Realistic Assessment of Comparative Costs:** It is essential to carry out realistic economic and technical evaluations and to compare costs of proposed projects with conventional alternatives. Comparative costing must be made mandatory in DPR preparation.
- **Financial Support for Discrete Components:** It is a useful strategy to break up the project cycle into discrete activities, such as pre-installation (pre-feasibility, community organization), manufacturing (supply of turbines), and installation, and institute separate financing mechanisms for each of these. This is a good mechanism for risk minimization as the appropriateness of the design can be verified by independent experts, who have not been involved in the project feasibility.
- **Role of the Village Community:** There should be a specific role for village-level community institutions, which should be made financially accountable by routing a part of the subsidy through them.

8.3.3 Subsidy Mechanisms for Off-grid Projects

- **Output-linked Subsidies:** It is recommended that a flat rate linked to output, per kW, be applied for micro-hydro systems as it provides a stronger incentive for low-cost projects than a percentage rate, the advantages being that it is easier to administer, eliminates the incentives for artificially inflating the cost of investment, and encourages searching for cost reduction options.

- **Ceiling on Financial Support.** There should be a ceiling on the subsidy amount that is provided, either in the form of maximum amount per installed kW capacity or as a maximum per household that will be connected. The latter option is most appropriate, and can be fixed on the basis of an analysis of the cost structures of recently implemented projects.
- **Building Support Services:** In addition to direct subsidies for investments and feasibility studies, indirect subsidies are also required to meet some of the costs of intermediation discussed earlier. These include subsidies for supporting the build-up of professional advisory and training services.
- **Minimum Level of Self-finance:** The government's subsidy support programs should insist on minimum levels of self-finance (including non-subsidized loan finance) of at least **50%**.

8.3.4 Tariff Policy

The tariffs in isolated grids should be allowed to vary. The revenue from the tariffs must be sufficient to cover the costs of operation, including the accumulation of reserve funds for major replacement or rehabilitation expenditure. If the population is unwilling to pay for such tariffs, the project should not be implemented. Guidelines should be provided, however, for tariff-setting for two reasons: to ensure the financial viability of community-owned projects (adequate allocations for major repairs and for loan repayments) and to reduce tensions in tariff negotiations between entrepreneur-owners and customers.

Bibliography

AEPC. 1999. Nepal Energy Sector Assistance Programme: Financial Assistance to Rural Energy by the Investment Component: Eligibility Criteria and Subsidy Levels for Project Support. Feasibility Study (May), AEPC/DANIDA

Allderdice, A., and Rogers, J.H. 2000. Renewable Energy for Micro-enterprise. National Renewable Energy Laboratory

Barnes, D., Jechoutek, K., and Young, A. 1998. Financing Decentralized Renewable Energy: New Approaches. Energy Issues No.15 (October), World Bank

Barnes, D.F., and Halpern, J. 2000. Subsidies and Sustainable Rural Energy Services: Can We Create Incentives Without Distorting Markets? Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP), World Bank

Barnett, A. 1998. The Provision of Access through the Expansion of Micro-hydro and Mini-grids. Paper presented at Village Power 98: Scaling up Electricity Access for Sustainable Rural Development, October 6–8, 1998, Washington, DC, United States

Brook, Penelope J. 2000. Better Energy Services for the Poor: Issues, Challenges and Opportunities for the Private Sector. Paper presented at Infrastructure for Development: Private Solutions and the Poor, 31 May–2 June 2000, London, United Kingdom

Cabraal, A., Cosgrove-Davies, M., and Schaeffer, L. 1996. Best Practices for Photovoltaic Household Electrification Programs: Lessons from Experiences in Selected Countries. Technical Paper Number 324, World Bank

Cecelski, E. 2002. Enabling Equitable Access to Rural Electrification: Current Thinking on Energy, Poverty and Gender. Briefing paper, Asia Alternative Energy Policy and Project Development Support: Emphasis on Poverty Alleviation and Women Asia Alternative Energy Unit (revised July 2002), World Bank

ESMAP. 2001. Best Practice Manual: Promoting Decentralized Electrification Investment. Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP), World Bank

ESAP. 2000. Guidelines for Tariff Setting for Micro-hydropower Schemes. Mini-grid Support Programme, ESAP, Nepal

ESMAP. 1999. Best Practice Manual: Promoting Decentralized Electrification Investment. Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP), World Bank

Foley, G. 1995. Photovoltaic Applications in Rural Areas of the Developing World. Technical Paper No. 304, Energy Series, World Bank

Gunaratne, L. 1998. Funding and Repayment Management of PV System Dissemination in Sri Lanka. Paper presented at the Conference on Financial Services for Decentralized Solar Energy Applications, 20-23 October 1998, Harare, Zimbabwe

Hande, H., Duffy, J. 2001. A Model for Sustainable Rural Electrification with Photovoltaics. Proceedings of the American Solar Energy Society Annual Meeting, April 2001

IDEAS. 2001. Energy Services Delivery Project: Sustainable Development of the Village Hydro Industry in Sri Lanka. Policy Development Component, Final Report (December), Infotechs – I/D/E/A/S Limited

IEA. 2003. PV for Rural Electrification in Developing Countries – A Guide to Capacity Building Requirements. Photovoltaic Power Systems Programme Report IEA-PVPS T9-03:2003 (March)

Khennas, S. and Barnett, A. 2000. Best Practices for Sustainable Development of Micro-hydro Power in Developing Countries. The Department for International Development, UK, and the World Bank

Martinot, E., Ramankutty, R., Rittner, R. 2000. The GEF Solar PV Portfolio: Emerging Experience and Lessons, Monitoring and Evaluation. Working Paper 2, Global Environment Facility

Miller, D., Hope, C., 2000. Learning to Lend for Off-grid Solar Power: Policy Lessons from World Bank Loans to India, Indonesia and Sri Lanka. Energy Policy 28 (2000), 87–105

Miller, A. and Martinot, E. Renewable Energy Markets, Policies, and Financing in Developing Countries: GEF Experience in World Bank/GEF Solar Home Systems Projects 1993-2000. Paper presented at the International CHP & Decentralized Energy Symposium, October 24-26, New Delhi, India

Mostert, W. 1998. Scaling-up Micro-Hydro, Lessons from Nepal and a Few Notes on Solar Home Systems. Paper presented at Village Power 98: Scaling up Electricity Access for Sustainable Rural Development, October 6–8, 1998, Washington, DC, United States

Murphy, R., Kamal, N., and Richards, J. 2002. Electrification and Development in Rural Bangladesh. Centre for Policy Research

NRECA. 2000. The Bangladesh Rural Electrification Programme Experience: Factors Contributing to Its Success. NRECA International Ltd (July)

Nagendran, J., 1999. Building Local Capacity in Rural and Renewable Energy: Emerging Lessons from Sri Lanka. Paper presented at World Bank Energy Week, 6–9 April 1999, Washington, DC, United States

Nagendran, J. Undated. Sri Lanka Energy Services Delivery Project Credit Programme: A Case Study

Newton, M. and Rovero, C., 1999. Private Sector Roles in Rural Energy Service Delivery: Alternative Models. Winrock International

Nexant. 2002. Rural Energy Services: Legal and Regulatory Review. (February), United States Agency for International Development, South Asia Regional Initiative for Energy

Pandey, B. 2000. End-use Promotion Strategy – Conceptual Paper. Final Report for Energy Sector Assistance Programme (August), AEPC/DANIDA

Pearce, D. and Webb, M. 1987. Rural Electrification in Developing Countries: A Reappraisal. Energy Policy (1987)

Prokaushali Sangsad Ltd. 1998. Market Assessment Survey of Solar PV Applications in Bangladesh. Final report, World Bank

REB. 2003. REB Management Information System (MIS). (December 2002)

RERED. 2002. Gamata Light: Electricity for Villages. RERED Project, DFCC Bank and Asia Alternative Energy Unit, World Bank, May 2002, Colombo, Sri Lanka

Rosario, A. V. Undated. Energy Sector Response to Poverty Alleviation. World Energy Council

Sohel, S. R. J. 2002. Economic Sustainability of Solar System in Rural Bangladesh. In Sadrul Islam, A. K. M. and Infield, D. G. (ed.). Proceedings of the International Conference on Renewable Energy for Rural Development, 2002

UNDP. 2000. Sustainable Energy Strategies: Materials for Decision Makers. United Nations Development Program

UNEP. 2002. Reforming Energy Subsidies: An Explanatory Summary of the Issues and Challenges in Removing or Modifying Subsidies on Energy that Undermine the Pursuit of Sustainable Development. United Nations Environment Program, International Energy Agency

Vaidya. Undated. Cost and Revenue Structures for Micro-hydro Projects in Nepal. Alternate Energy Promotion Centre, Kathmandu, Nepal

WII. 2003. India Renewable Resources Development Project: Lessons and Emerging Good Practices. Winrock International India (September 2003), Asia Alternative Energy Program and South Asia Energy and Infrastructure Unit, World Bank

World Bank. 2002. Project Appraisal Document on a Proposed Credit in the Amount of SDR 153.0 million (US$ 190.98 million equivalent) and a Global Environment Facility Trust Fund Grant in the Amount of SDR 6.6 million (US$ 8.2 million equivalent) to the People's Republic of Bangladesh for a Rural Electrification and Renewable Energy Development Project. World Bank Report No: 23887-BD (May 31), Energy and Infrastructure Sector South Asia Regional Office

World Bank. 2002a. Bangladesh: Rural Electrification and Renewable Energy Development Project. Office Memorandum (May 17), World Bank/IFC/MIGA.

World Bank. 2002b. Why are Power Sector Reforms Important for the Poor. World Bank

World Bank. 1995. Energy Strategies for Rural and Poor People in the Developing World. World Bank

Zomers, A. N., Bosch, H. 2000. Final Evaluation of the Netherlands Program Aid to the Rural Electrification in Bangladesh. (January), Royal Netherlands Embassy Dhaka, Bangladesh